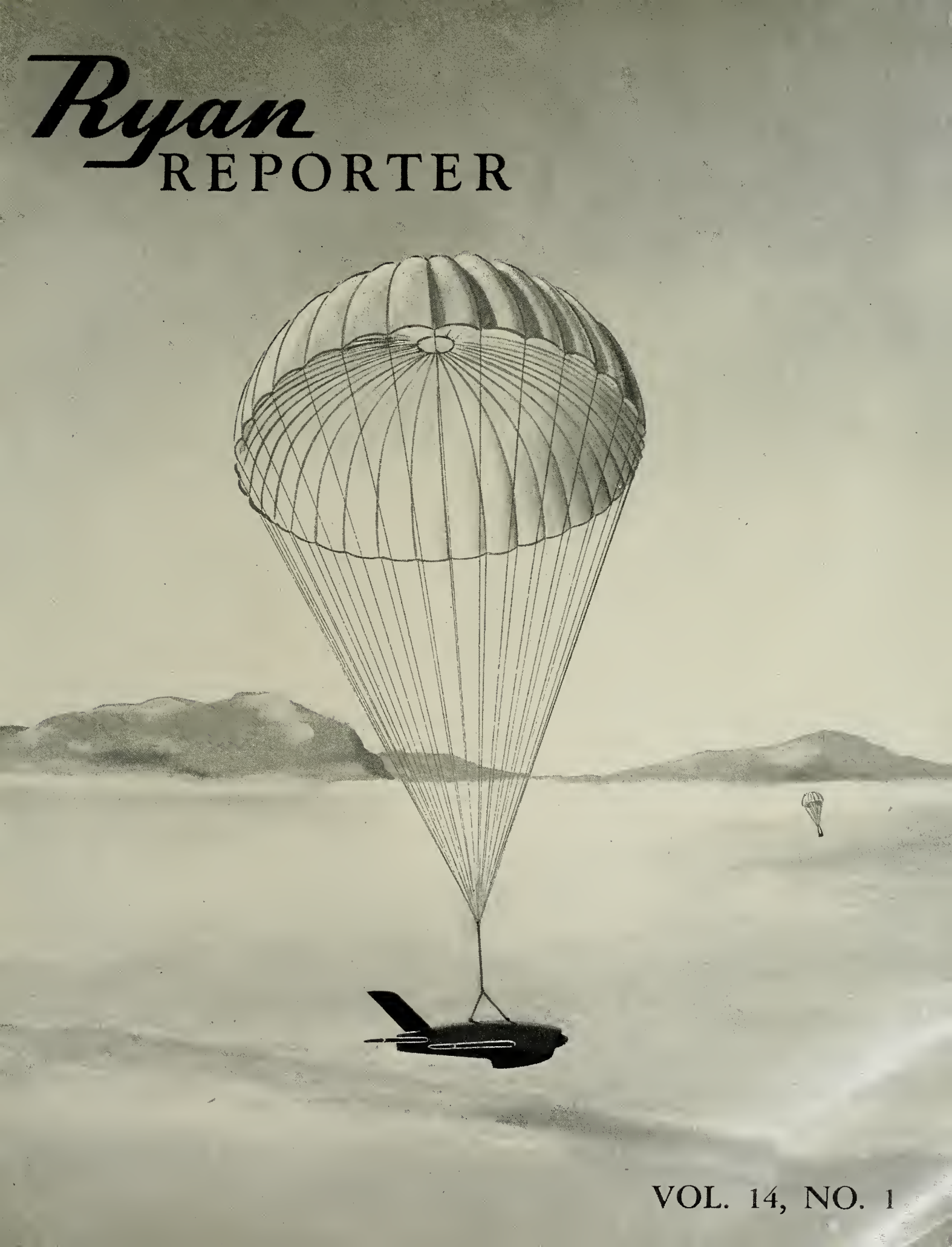
Ryan REPORTER



VOL. 14, NO. 1

FELLOW PLAYERS— not rivals

One of the most distressing things about labor-management relations in recent years is the bitter animosity that frequently exists. The profits made by the employer are often cited by those who would for their own purpose stir up strife.

This is difficult to understand when one stops to realize that capital, management and labor are actually players on the same team. The welfare of each is inseparably bound up with the welfare of the others.

* * *

There is no other country quite like America because in no other nation will you find the kind of freedoms upon which the U.S. has been built —and upon which we have achieved world leadership and the highest standard of living.

When this nation was founded, there was born with it a new concept of individual liberty. It was a freedom under which man was accountable only to his God and his conscience, so long as he did not infringe upon his neighbor's equal right.

The society we built upon this foundation has astonished the world. We had created an environment which for the first time called forth the best efforts of all people.

Under this environment of co-operation, comradeship and mutual confidence, men and women dared to risk their savings in building America. But also needed were the initiative and brains of intelligent management, and equally important was the "know-how" of skilled labor to translate ideas into finished products. Capital, management and labor were all indispensable members of the team.

* * *

A good illustration of this is the story of the old Arab who realized he had only a few years to live and was anxious to determine which of his three sons should succeed him as head of the family. He told them that in a distanct land scientists had developed many amazing things, and they were to travel to this land. On arrival each son was to devote six months to finding a gift that he thought would contribute most to his father's welfare.

When they met at the end of the six months in this distant land, each displayed the gift he had acquired. One had a magic carpet on which people could be transported at amazing speed. Another had obtained a magic medicine that would cure any ill, while the third son had acquired a magic glass through which one could look into any home in the world.

When they turned the magic glass on their father's home, they were dismayed to see that the old Arab was dying. They immediately boarded the magic carpet and were speedily carried back home. There the magic medicine saved their father's life.

Now which of the three sons made the most important contribution? The magic medicine would have been of no help if they had been unable to return home in time, and this would not have been possible without the magic carpet. But they would not have even known of their father's illness without the magic glass. So it is obvious that the contribution of each son was worthless by itself.

The same situation exists with capital, management and labor. The laborer is worthy of his hire; it's good business as well as justice to pay labor its just proportion. By the same token, management is entitled to its rewards and capital must have an incentive for its risks.

* * *

The three—capital, management and labor—are not rivals but fellow players on the same team. What benefits one helps the others, and what hurts one injures the other two.

by Graham Patterson, Publisher, PATHFINDER MAGAZINE

Ryan specialists arrive in company Navian at United Air Lines' San Francisca shops to discuss exhaust system maintenance methods.

GLOBAL LIAISON

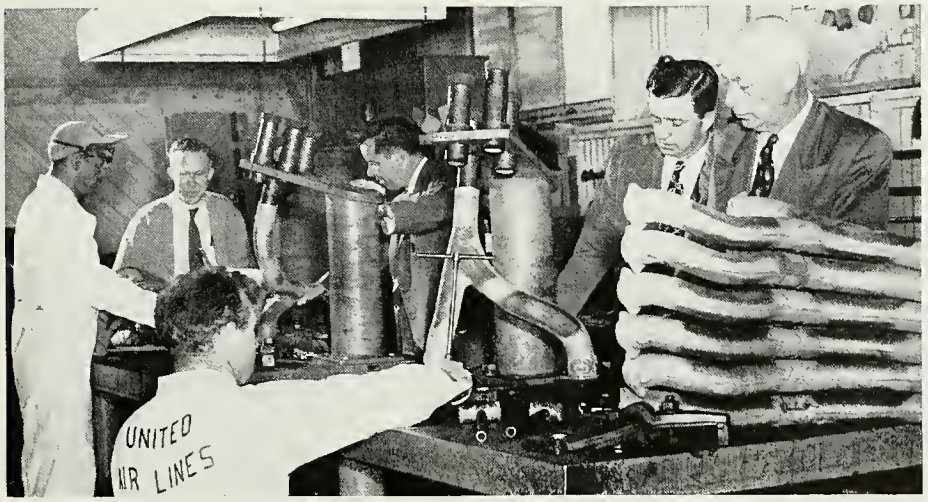
Ryan's exhaust systems specialists are there when needed

A NEW transport is appearing on airlines throughout the world, and that means Ryan service representatives will be packing their bags again and going on long trips.

The airliner is the Convair 340, an advanced version of the famed Convair 240, which has been making spectacular safe-flying history on domestic and foreign airlines during recent years.

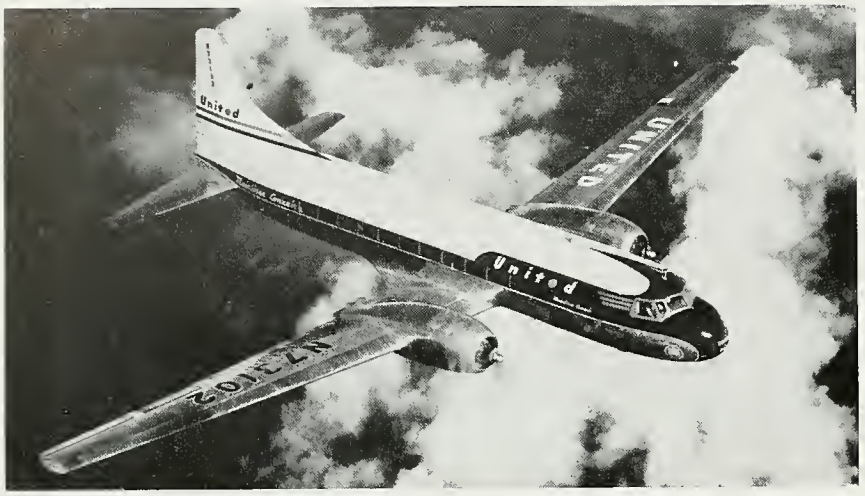
With almost 200 Convair 340's on order, Ryan's customer service department already has swung into high gear with the specialized service it provides both to the transport manufacturer and to the airlines operating the planes equipped with Ryan exhaust systems. Every Pratt & Whitney R-2800 engine in the 340 will be equipped with the newly designed Ryan "siamese"-type exhaust sys-

(Continued on next page)



Ryan and Douglas representatives confer with United Air Lines maintenance men. At head of wark bench is George Cassidy, United sheet metal fareman. Others, left to right, are C. L. Faushee, Jr., and Gilbert M. Hansen of Ryan, and W. J. Lockett of Douglas.

When Hansen recently visited Japan to advise on C-124 exhausts, he observed ambulance role of the giant Globemasters.



One of the newest transports appearing on air routes throughout the world is the Convair 340, for which Ryan builds newly designed "siamese" type exhaust systems. Photo above shows one of first of these planes, delivered to United Air Lines.

With almost 200 Convair 340s on order by domestic and foreign airlines, Ryan already is providing specialized liaison service to both the manufacturer and the airlines using these planes, equipped with exhaust systems built by Ryan.

tem, providing greater thrust than the earlier exhaust systems on the Convair 240.

Before the transports are delivered to the airlines, their maintenance personnel are supplied with parts lists, service instructions, and overhaul and welding information in handy published form.

Soon such a liaison specialist as C. L. Foushee, Jr., service manager of Ryan's Metal Products Division, will follow up by visiting the airlines' maintenance and overhaul depots. He'll confer with power plant engineering and maintenance personnel on all details of design and performance. He'll help train men in the handling of the complex exhaust systems. He'll advise on the best methods of installation and removal of the equipment, replacement of parts and maintenance of various units. Foushee will brief the maintenance crews on types of wear and service factors to watch for and how to test for signs of wear.

Then, after the 340's have actually gone into service, he'll keep in close contact with Convair engineers and with every airline on their actual service experience. This may take repeated swings around the country, and perhaps to foreign lands. When highly technical advice is needed, Ryan engineering and inspection representatives will also be ready to make analyses on the spot.

The story of Ryan's servicing the airlines on the 340 exhaust systems will be history repeating itself. In recent years, the same procedure was successfully followed in the introduction of the Douglas DC-4 and DC-6 transports, the Boeing 377 Stratocruiser and the Convair 240. Thousands of Ryan exhaust systems have been built for these rugged standard workhorses of the sky, as well as for their military counterparts and for other planes.

There is hardly an air route in the world not served by transports using Ryan exhaust systems. Besides the planes mentioned, these systems are installed in the old reliable DC-3. Certain parts of the exhaust systems on the Martin 202 and 404 transports are Ryan-built. In the military field, constant checkups in the field are made on Ryan exhaust systems in Douglas C-47, C-54, C-74 and C-124 transports; in Boeing C-97 Stratocruisers; Fairchild C-82 and C-119 Flying Boxcars and Boeing B-50 bombers.

Maintenance techniques change with the constant advancements in research that develop metals better able to withstand the increasing operating temperatures of today's powerful engines. Ryan

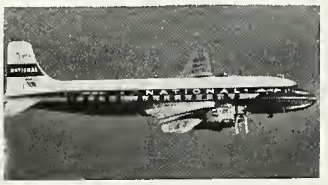
(Continued on page 22)

Scoreboard of Ryan Exhaust Systems on U. S. Airlines

AMERICAN AIRLINES

← Convair 240, Douglas DC-6 and DC-4

Convair 340, Douglas DC-6 and DC-4 →



NATIONAL AIRLINES

BRANIFF INT'L. AIRWAYS

← Convair 240 and 340, Douglas DC-6, Douglas DC-4 and DC-3

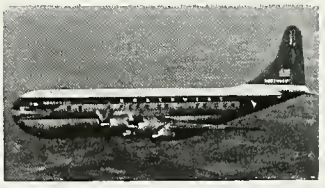
Convair 240 and 340, Douglas DC-3 →

NORTHEAST AIRLINES

CAPITAL AIRLINES

← Douglas DC-4

Boeing 377, Douglas DC-4 and DC-3 →



NORTHWEST AIRLINES

COLONIAL AIRLINES

← Douglas DC-4 and DC-3

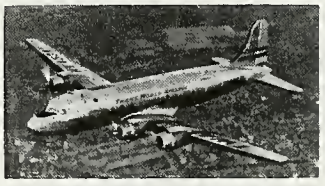
Boeing 377, Convair 240 and Douglas DC-6, DC-4 and DC-3 →

PAN AMERICAN AIRWAYS

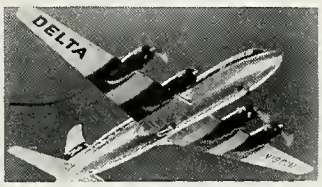
CONTINENTAL AIR LINES

← Convair 240 and 340, Douglas DC-6, DC-4 and DC-3

Douglas DC-4 →



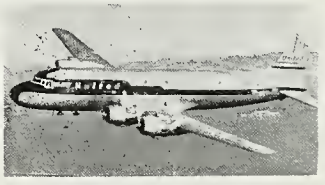
TRANS WORLD AIRLINES



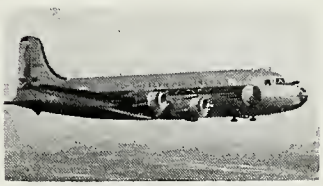
DELTA C. & S. AIR LINES

← Convair 340, Douglas DC-6 and DC-4

Boeing 377, Convair 240, Douglas DC-6, DC-4 and DC-3 →



UNITED AIR LINES



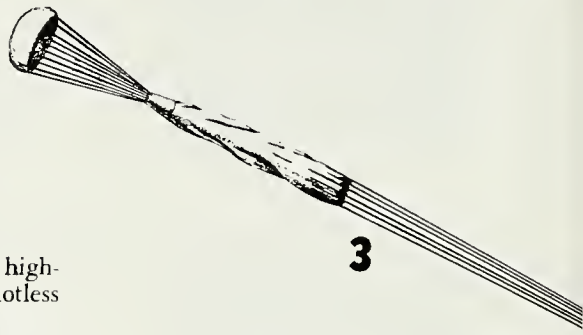
EASTERN AIR LINES

← Douglas DC-4

Convair 240, Douglas DC-6, DC-4 and DC-3 →

WESTERN AIR LINES

UNDER



SUCCESSFUL parachute recovery of some of the heaviest objects ever dropped at speeds up to 600 miles an hour has been accomplished by Ryan Aeronautical Company and the United States Air Force in extensive service tests at Holloman Air Development Center, Alamogordo, New Mexico.

Jet fighter pilots have been ejected from their cockpits in flight emergencies and dropped by parachute at equivalent speeds, but the weight of a pilot is only about a tenth as much as the articles used in the recent tests.

Through use of two comparatively lightweight parachutes, heavy loads have been carried to earth at near-sonic speeds in the Ryan-Air Force test program conducted during development of the high-speed Ryan Q-2 jet-propelled pilotless target plane.

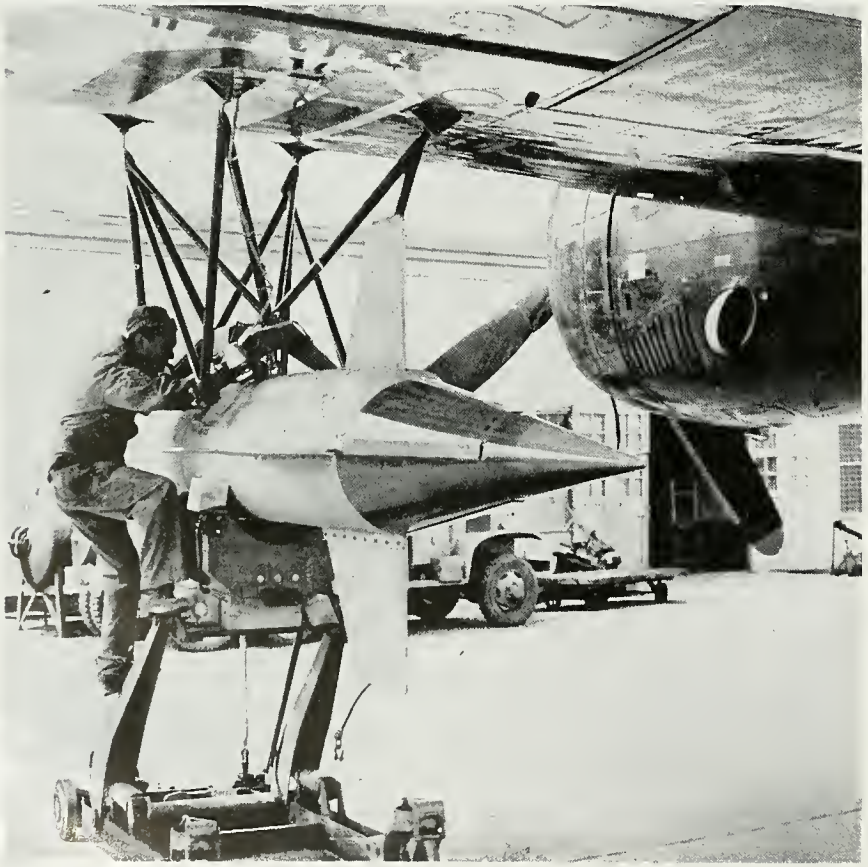
These loads have been dropped undamaged at speeds far greater than those at which the military services regularly drop such heavy combat equipment as howitzers, jeeps and other vehicles, ammunition and various types of weapons from cargo planes.

The Ryan Q-2 high-performance jet target planes being developed for the Air Force, Army and Navy are now being recovered intact after each target test run, enhancing the economy feature of drones which may thus be repeatedly employed in air-to-air and ground-to-air target practice.

The remote-controlled Ryan pilotless plane is about half the size of a jet fighter, can attain fighter speeds and is designed to simulate fighter evasive tactics. So far, only silhouette drawings of the Q-2 have been released for publication by the Department of Defense.

To obtain repeated use of the targets, a two-stage parachute recovery system had to be designed. The "letdown" had to be accomplished without harm to the delicate equipment inside the Q-2. These requirements led to development

Manner in which test vehicle was attached to Air Force launching plane is shown in photo below. Tail cone contains revolutionary new parachute release system.



New parachute syste

jet planes at 6

of an entirely new parachute release system by Ryan and the Prevost F. Smith Parachute Company, Gillespie Field, El Cajon, California.

The main canopy is about half the weight of a conventional design parachute of comparable size. It billows out after release of a small "drag" parachute. Both chutes are housed aft of the tail surfaces of the drone. This location minimizes the possibility of fouling during deployment.

Here is how the system works

The small conical drag chute container is automatically released; then the drag chute flares out, bringing the first sharp deceleration of the Q-2.

After a given time interval, the main parachute container is released. The drag chute pulls the main chute container rearward, and the main chute is deployed from a bag.

This deployment bag is used to insure that the suspension lines are deployed

(Continued on page 26)

ARREST

ecovers Ryan Q-2 pilotless

. p. h. speed

Numbered sketches show operation of the two-stage parachute recovery system developed for Ryan Q-2 pilotless jet target plane. (Sketches show pipe-like configuration of test vehicle which simulated Q-2 weight.)

1. Test vehicle in free flight with parachute containers attached.

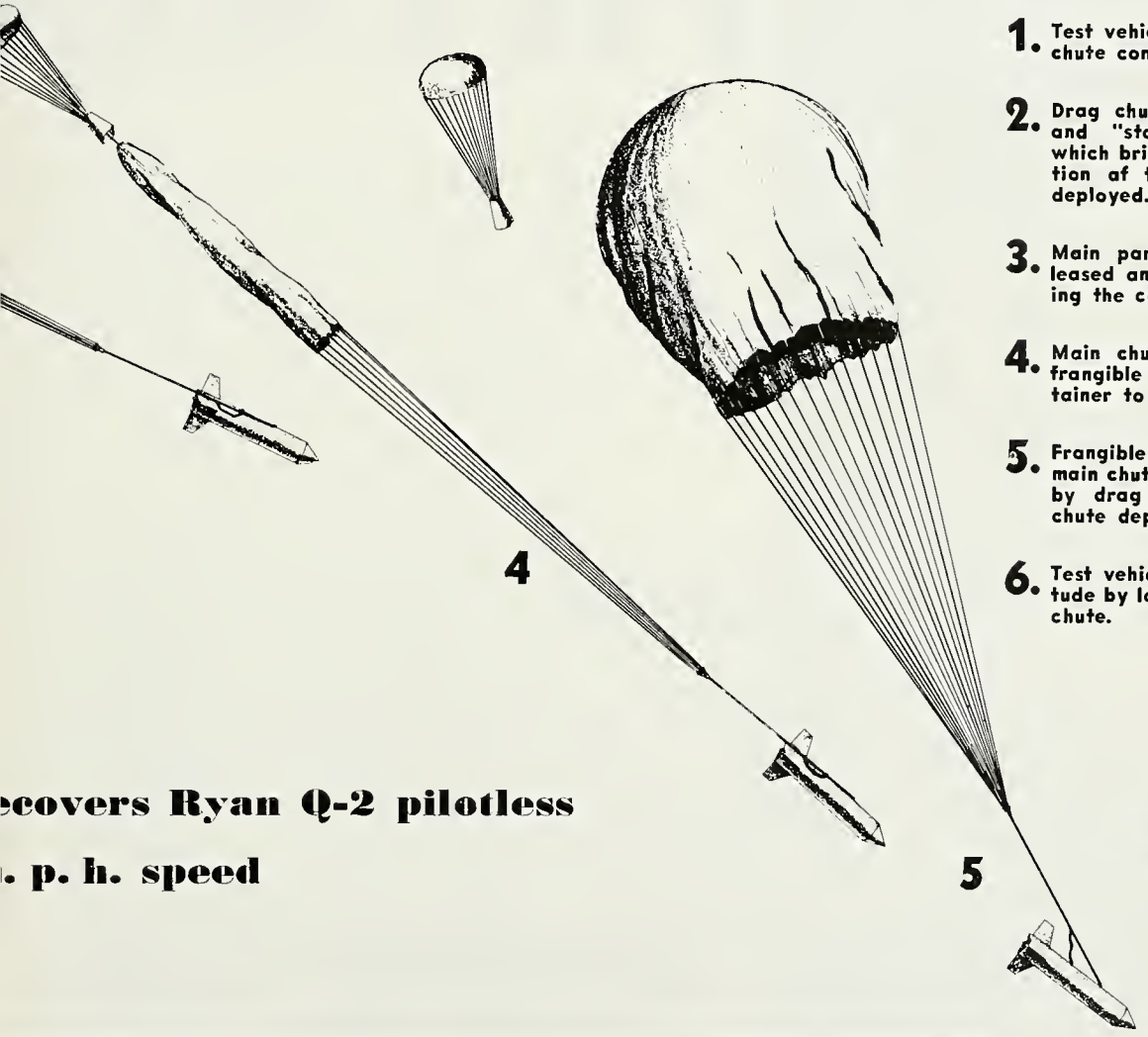
2. Drag chute cone has been released, and "stability" type drag chute, which brings the first sharp deceleration af the vehicle, has been fully deployed.

3. Main parachute cone has been released and drag chute is shown pulling the container off the main chute.

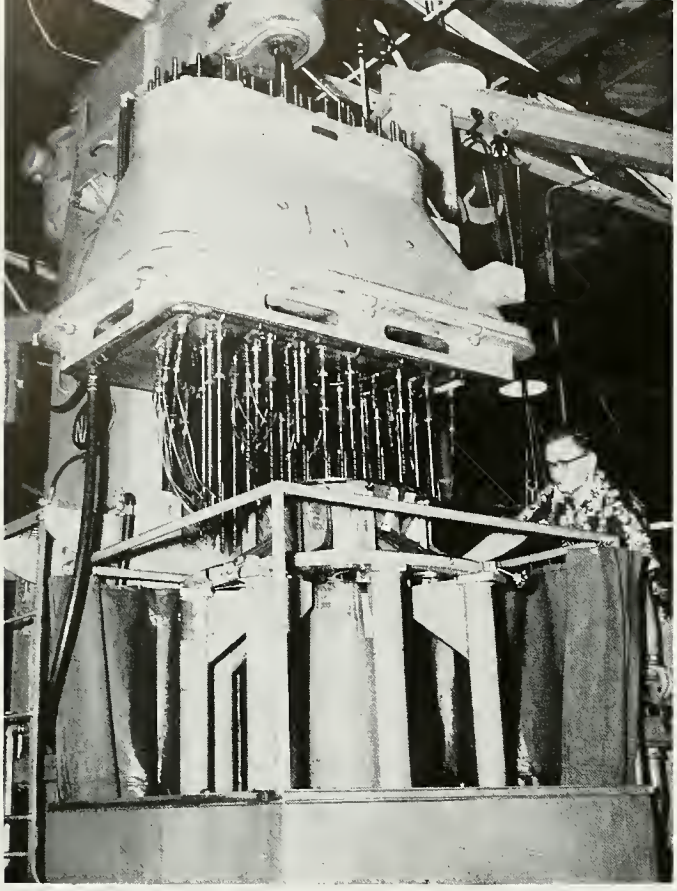
4. Main chute is fully extended. Note frangible cord connecting chute container to vent of main parachute.

5. Frangible cord has been broken and main chute container is being lowered by drag chute as main suspension chute deploys.

6. Test vehicle is lowered in flight attitude by large formed-gore main parachute.



Air Force and Ryan personnel at Holloman Air Development Center, Alamogordo, N.M., check shroud lines of recovery parachute billowing out in special test on ground.



Aft frame drilling time is cut 90 percent by this big Natco which drills 40 holes at once under control of Bob Glassey.

AFT FRAMES

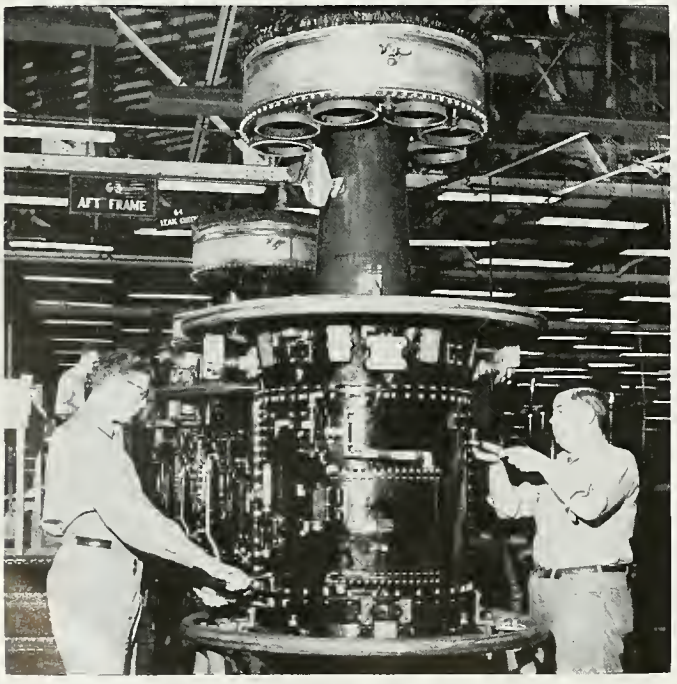
Little known aft frames play the main supporting role in the jet story

RYAN has attained a high production rate on one of the most difficult-to-build structures used in General Electric J-47 jet engines. Labeled "aft frames," these components are undoubtedly the most complex stainless steel products which Ryan has made.

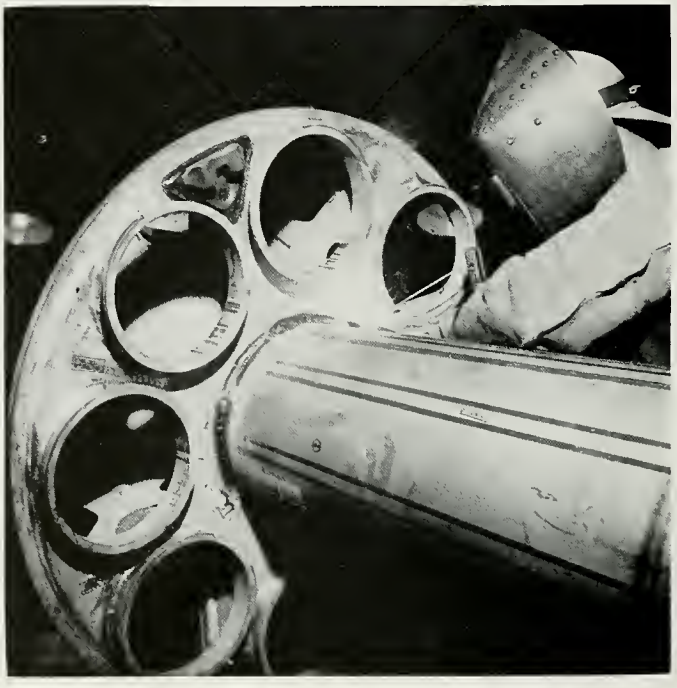
In spite of the reams of publicity which have been written about jet power plants, few know what an aft frame is or realize its importance to the function of a jet engine. This is not surprising. The limelight has been hogged by sizzling combustion chambers, whirling turbine wheels and flaming afterburners. With no moving parts and a prosaic name, the aft frame seems to be consigned to anonymity. Yet, it is one of the most important structures of the engine and merits top consideration because of the amazing amounts of welding and machining which are incorporated within its skeleton-like contours.

Actually, the aft frame may be thought

Ryan aft frames form upper structure of these jet engines which are assembled, vertically, at G-E's Evendale plant.



Russell Stein arc welds burner plate to barrel in aft frame assembly which requires extensive welding of high quality.



of as the "backbone" of the "hot end" of the jet engine. It is the structural member which holds the seething combustion chambers, transition liners and turbine and compressor cases together. It contains the housings which support two main bearings of the high speed turbine-compressor shaft. This is a major assignment because the alignment of these bearings is critically close. Through the aft frame, air cooling and lubrication are provided for the rotor bearings.

Each aft frame contains about 150 feet of high quality welding, 220 precision-drilled or tapped holes and more machining than any other Ryan-made component. Coupled with these startling requirements are a list of manufacturing tolerances which are among the most exacting encountered in the industry.

In configuration, the aft frame consists of a slightly tapered, cylindrical barrel to which are attached a number of heavy-gauge, machined flange sections. Near the aft end of the barrel a large, circular burner plate is slipped on and welded. By means of eight flanged eyelets in its periphery, this plate positions the combustion chambers and holds them in alignment. The aft frame is bolted to the compressor case, in front, and to the turbine case, at the aft end. The high speed turbine-compressor shaft passes through the barrel of the aft frame and is supported by two main bearings which are housed within its interior.

The keywords of the aft frames' function are strength and precision. Because all of the other "hot end" components depend upon the aft frame for their carefully balanced performance, it must be extremely strong and perfectly dimensioned. To obtain these features every innovation in design, fabrication and inspection techniques has been utilized.

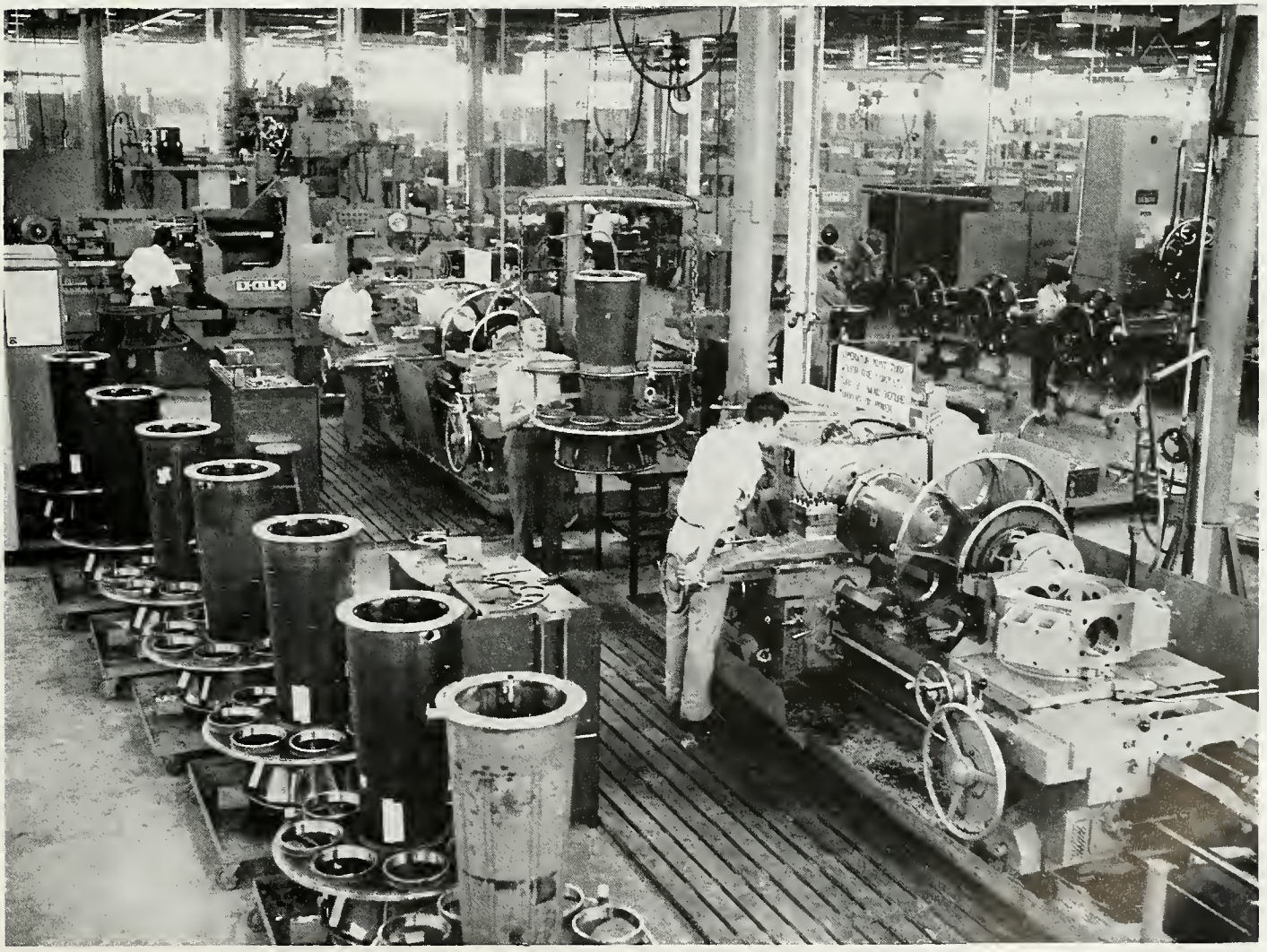
All component parts for the aft frames are pressed out in steel dies with large presses. This fast method provides exact-size parts and eliminates practically all handwork such as sawing and filing. In the case of the heavy burner plate assembly, nearly all of the 600-ton capacity of the big Warco press is used to blank out this piece.

The barrel is rolled into shape and welded along its longitudinal seam on automatic inert-gas welding machines. A series of curved steel strips are seam-welded into the interior of the barrel to make it a double-walled affair which is extra strong and monocoque in design.

All parts of the aft frame are joined together by precision welding methods with no other means of attachment being used. Sixty-four feet of electric seam welding are used to form the barrel alone. More than seventy-five feet of manual metallic arc welding is employed to attach the five major flanges to the barrel and join other details.

(Continued on page 20)

Geared to high volume output, complex aft frames flow through an impressive array of modern machine tools in Ryan's jet building.



DOUBLE
WASP

There's still a lot of life left in the piston engine —especially Pratt & Whitney Aircraft's Double Wasp

THE roar of the piston engine is still heard, loud and strong, over America's aviation scene.

And in this time which has come to be known as the Jet Age, one piston engine, in particular, continues to set the standard for air transport operations.

This is the Pratt & Whitney Aircraft R-2800 Double Wasp, an engine so efficiently designed almost 16 years ago that, with constant improvements on the basic concept, it still provides the power for the most modern airliners.

Airlines throughout the world are operating transports designed around the R-2800—the Douglas DC-6, DC-6A and DC-6B, the Convair 240 and 340, and the Martin 202 and 404. The Air Force's C-118 and the Navy's R6D military versions of the DC-6A are similarly equipped.

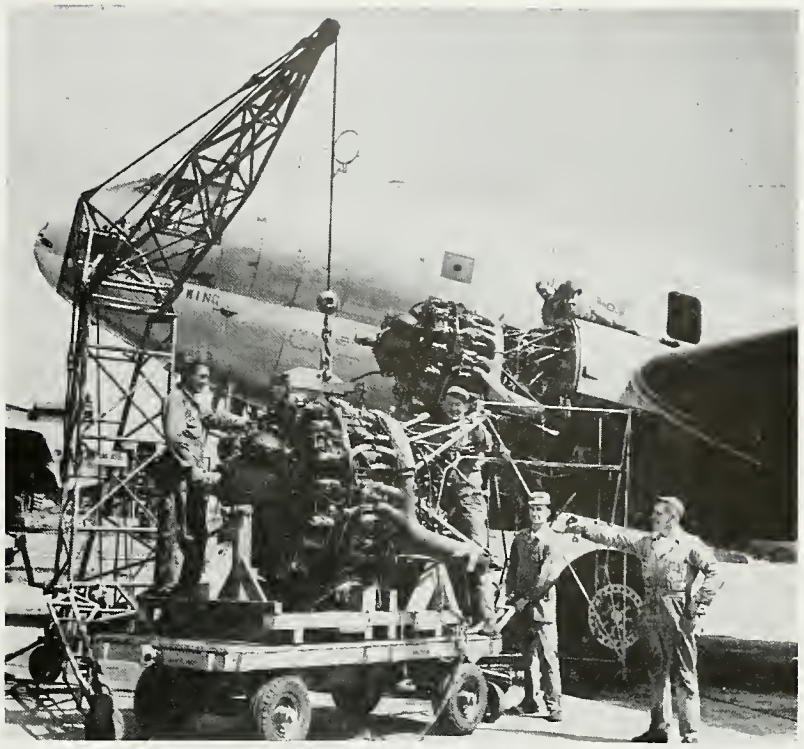
On most of these planes, the exhaust systems are Ryan-built — the airlines' standard for handling the searing gases of the 18-cylinder Double Wasps.

Ryan's association with the remarkable R-2800 dates back to early in World War II, when this engine powered three of our first-line fighters, the Grumman F6F Hellcat, the Republic P-47 Thunderbolt, and the Chance Vought Corsair, and a torpedo bomber, the Consolidated Vultee TBY.

Large quantities of Ryan exhaust systems were produced for the F6F and the TBY during the war.

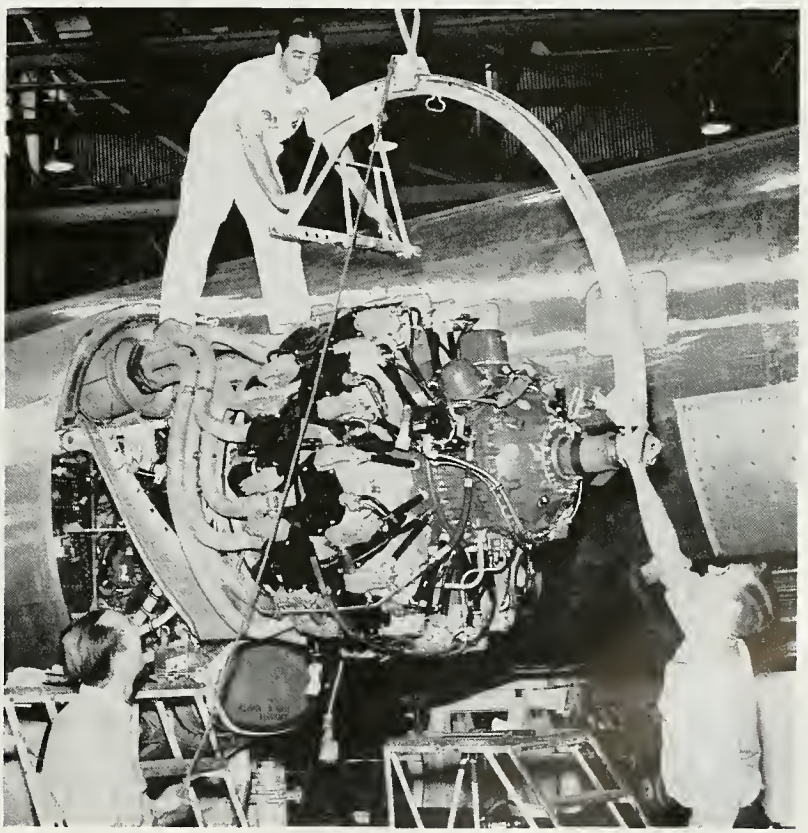
Since this powerful twin-row radial engine went into mass production, in 1940, approximately 120,000 have been built, providing more than 250 million horsepower for thousands of military and commercial aircraft. Designated the R-2800 because it has 2,800 cubic inches piston displacement, the Double Wasp was rated at 1,800 horsepower in its first experimental model. The earliest production models were the first aircraft engines to turn out more than 2,000 horsepower. Today's R-2800 has a rating

(Continued on page 27)



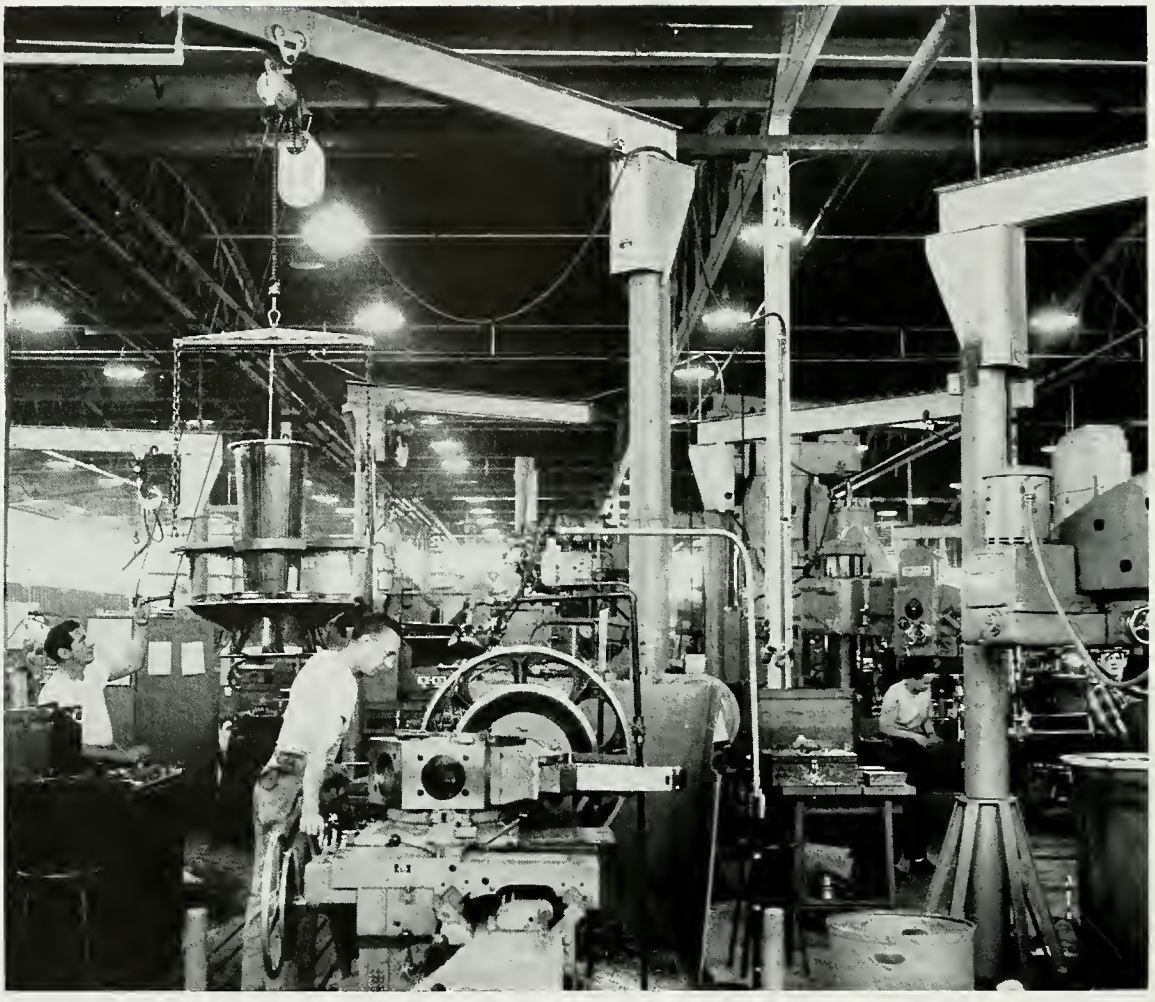
In military, as well as commercial air transport, ever-improving R-2800 piston engines with Ryan exhausts continue to provide reliable performance.

Another Double Wasp is installed on new Convair 340. Searing gases of this successful engine are carried off in Ryan-built exhaust systems.



The mighty Pratt & Whitney Aircraft R-2800 Double Wasp was so efficiently designed almost 16 years ago that it is still the top standard of air transport operations.

SPACE CONTROL



Saving space and manpower, Ryan's "forest" of swinging hoists load the big jet engine structures into machine tools. Powered by Keller air motors, these hoists can handle 2000-pound parts with gentle care.

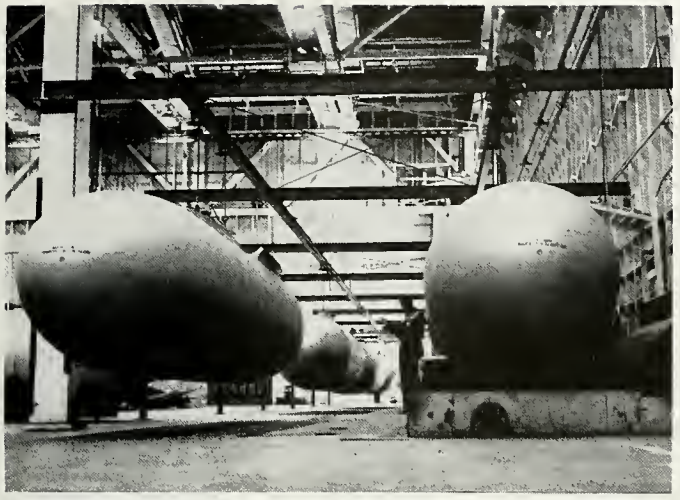
TO Einstein, space is finite, unlimited and inseparably wedded to time in a continuum which permeates the universe. But to Ryan, space is the stuff out of which production comes and it is definitely limited by factory floor area.

Of course, this space can be substantially "stretched" by the installation of more efficient machines and the development of more ingenious methods. For instance, Ryan's six new Warner and Swasey gap lathes, installed to cut in half the machining time on jet exhaust cones, are also saving valuable space. Because they will machine both ends of the cones in one set-up, they have eliminated the space formerly needed to store a dozen big cones at each machine between set-ups.

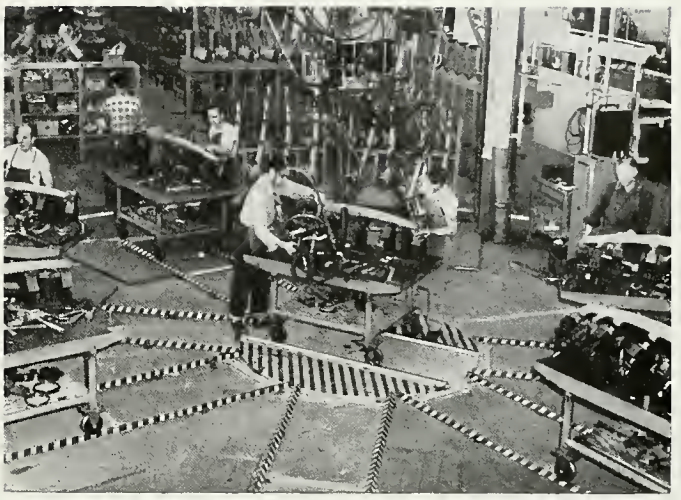
Particularly important to the on-going effort to save space at Ryan is that phase of production which is concerned with parts handling. No one can fail to be impressed by a modern machine tool, such as Ryan's fast roll-spot welding machines, which can weld afterburners in less than half the time of former machines. But few realize that such savings can be lost in the confusing shuffle of parts handling if the same imagination, devoted to the utilization of new machines, is not given to production flow and layout problems.

At Ryan, this responsibility is the chief concern of Methods Engineering, headed by Robert L. Clark. Their objective, easier said than done, is to absorb the largest volume of business which the

This is the first in a series of STSM articles devoted to Ryan efforts to Save Time, Space and Money in production. Each successful attempt to conserve these elements brings greater benefits in prices, wages and earnings to Ryan customers, employees and stockholders. While it is the direct responsibility of only a few to plan each project, every Ryan employee can make an important contribution to the results that are achieved by applying his ideas and initiative to the job he performs.



Like ghostly Zeppelins, Ryan's huge fuel tanks roll through painting and drying areas on monorail suspension system.



Fifty percent space saving is realized with ingenious turntable and overhead spotwelders which serve seven fixtures.

plant's facilities can handle. Or, to put it another way, they strive to put factory space, tools and manpower to the highest economic use.

This would be a good deal simpler if Ryan were building a single product in mass production, such as a water heater or refrigerator. In that event, Methods Engineering could determine what factory space should yield, and control that yield over a prolonged period, from flat sheet stage to finished product. But Ryan manufactures three basically different types of products and works as both prime and subcontractor.

One section builds airplanes and big airframe structures of aluminum, such as Boeing fuselages and fuel tanks, which require large space allocations and substantial application of small hand tools. Another fabricates stainless steel parts for jet engines which demand an array of big machine tools and furnaces due to their high precision specifications. Still another division builds aircraft exhaust systems which must be shuttled back and forth between inumerable forming, welding, heat treating and machining operations because of the temperamental behavior of the alloys used.

With many of the products, Ryan does not control the design but must manufacture to a customer's drawings and is frequently called upon to modify the design in production to meet ever-changing developments in aerodynamics and metallurgy. Also, production runs are relatively limited in the aircraft industry and the extent of a contract cannot be forecast far into the future.

Because of these factors, Ryan methods

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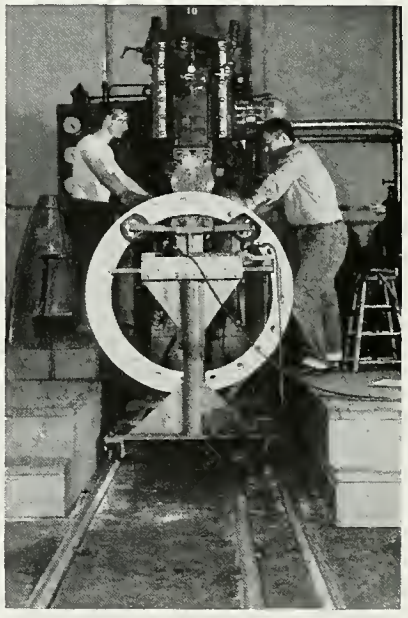
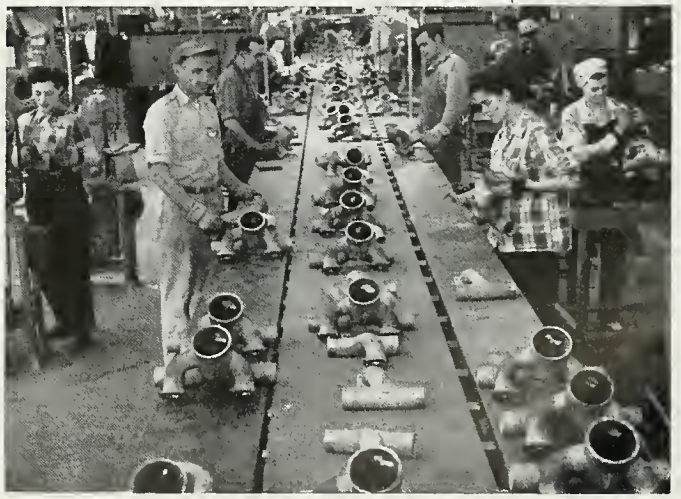


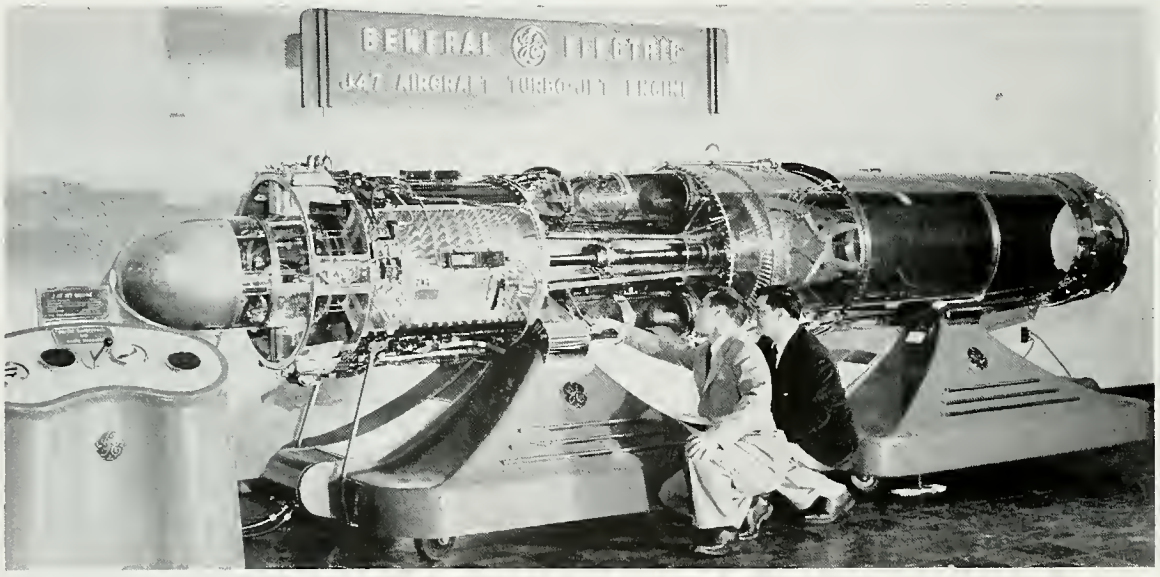
Steel tracks and mobile fixtures convey heavy tank sections to seamwelders and position work between wheel electrodes. ➔

Combustion chambers for jet engines are welded, inspected and boxed for shipment from roller conveyor line at Ryan.

Motorized conveyor belt has doubled production and cut space forty percent in manufacture of exhaust manifolds for tanks.



JET ENGINES IN THE NEWS



Twa successive speed marks have been set by F-86A and F-86D Sabrejets with G.E. J-47 aircraft turbo-jet engine. Newest in series is equipped with afterburner, such as Ryan now builds, to give it extra power.

GENERAL ELECTRIC J-47 HELPS SET JET SPEED RECORD

SMASHING speed records has become a habit with the General Electric J-47 jet engine, for which Ryan Aeronautical Company is in volume production of component parts.

When a completely combat-equipped North American F-86D Sabrejet flown by Capt. J. Slade Nash recently set the new speed mark of 699.9 miles per hour over the Salton Sea, in the Imperial Valley, it merely was replacing the record set in 1948 by an F-86A model equipped with one of the earlier models of the J-47 engine.

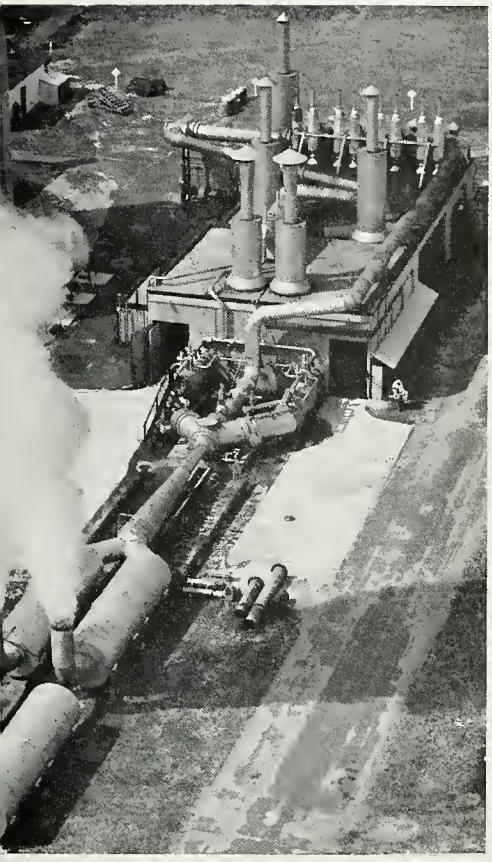
"We were very pleased with the part our jet engine had in helping to break the record set by an earlier model of the F-86, which was also powered by a G-E jet engine," said C. W. LaPierre, general manager of G-E's Aircraft Gas Turbine Division. "It's this sort of constant improvement, brought about by aggressive research and advanced design, combined with an efficient factory production team, which will keep our Air Force in top world position."

The newest power plant, the J-47-17, is a turbojet with afterburner, which in effect is an extra engine carried in the aft fuselage section. The afterburner is a "re-heat" device where additional fuel is burned in the exhaust stream to provide an extra burst of power.

The F-86D attained its tremendous speed at sea level, where fuel requirements are much greater than at altitude, where the air pressure on the plane is four times greater, and where such aerodynamic problems as drag, buffet, stability and structural strength are aggravated.

In the F-86D, America's first one-man interceptor, the Air Force has made giant strides toward automatic flight in any kind of weather. Automatic electronic power engine controls regulate the fuel flow for best performance in all combinations of speed, altitude, engine RPM, temperature and engine airflow. This makes possible successful completion. of missions under severe icing conditions, which in the past have been a serious problem in jet operation. Hot air from the engine's compressor is bled to hollow parts of the nose, with temperatures high enough to melt any ice crystals forming.

Without ever seeing an enemy plane, except on his radar scope, the pilot of an F-86D can fire rockets with amazing accuracy, an automatic gun sight computing range, speed and probable course of the target.



Air view of Pratt & Whitney Aircraft's ramjet laboratory in East Hartford, Conn.

RAMJETS NEXT FOR PRATT & WHITNEY

LEADER for many years in the piston engine field with its constantly improving series of dependable Wasp engines, Pratt & Whitney Aircraft has plunged deeply into every phase of jet engine production and development. Its recent entry into ramjet development for high-speed guided missiles gives Pratt & Whitney a complete program of building all types of air-burning engines.

As the least-developed member of the jet family, the ramjet holds promise of becoming one of the most powerful.

P & W began jet production four years ago with its centrifugal-flow Turbo-Wasp and is now also producing an axial-flow turbojet engine of its own design, the powerful J-57, with which the mighty new eight-engined heavy jet bomber, the Boeing B-52, is equipped.

The company also has designed the T-34, a turboprop, or jet-propeller engine, now in production.

Various types of ramjet engines will be developed for the U.S. Navy in the newest project, climaxing six years of research on ramjets at East Hartford, Conn.

The ramjet development will present some of the most complex problems in P & W's distinguished history. Although basically simple in design, ramjet engines present complex problems in control of the air-fuel mixtures in the extremely fast flow of air through the engines. They don't actually hit their stride until supersonic speeds are reached.

This "stovepipe with a fire in it" is essentially a tube open at both ends. When it has been brought to a high speed, the open-mouthed ramjet compresses its own air supply by "ramming" forward. As the missile shoots ahead, the air is compressed in the open front end of the engine and is pushed under high pressure into the burners.

The combustion of the air and fuel mixture shoots hot gases out of the rear of the engine to thrust the missile for-

(Continued on page 27)

WESTINGHOUSE ANNOUNCES NEW J-40 JET

A TURBOJET engine that develops thrust equivalent to approximately 25,000 horsepower at today's jet flight speeds, has been developed by Westinghouse Electric Corp. for the Navy.

This is a new model of the J-40, which has gone into production to provide this country with one of the world's most powerful engines of its kind. First it had to pass the Defense Department's severe 150-hour qualification test, equivalent to more than 75,000 miles of actual flight—three times around the world at the equator.

Among new Navy fighter planes scheduled to be powered by the new engine are the sensational McDonnell F3H "Demon" and the Douglas F4D "Skyray."

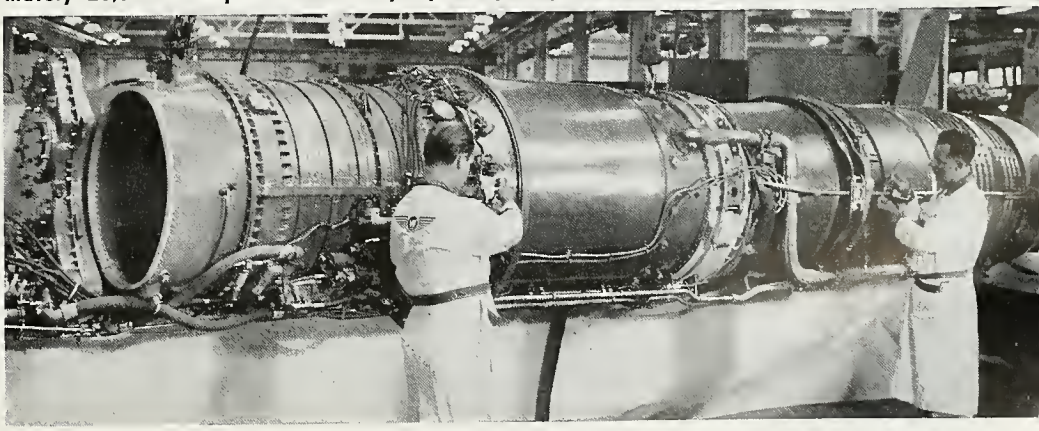
An afterburner provides some of the tremendous power of the new J-40, which like all Westinghouse jets, is of the axial flow or straight-through design. Although almost 25 feet long and about 40 inches in diameter, it is surprisingly light and produces more thrust per square inch of frontal area than any other turbojet.

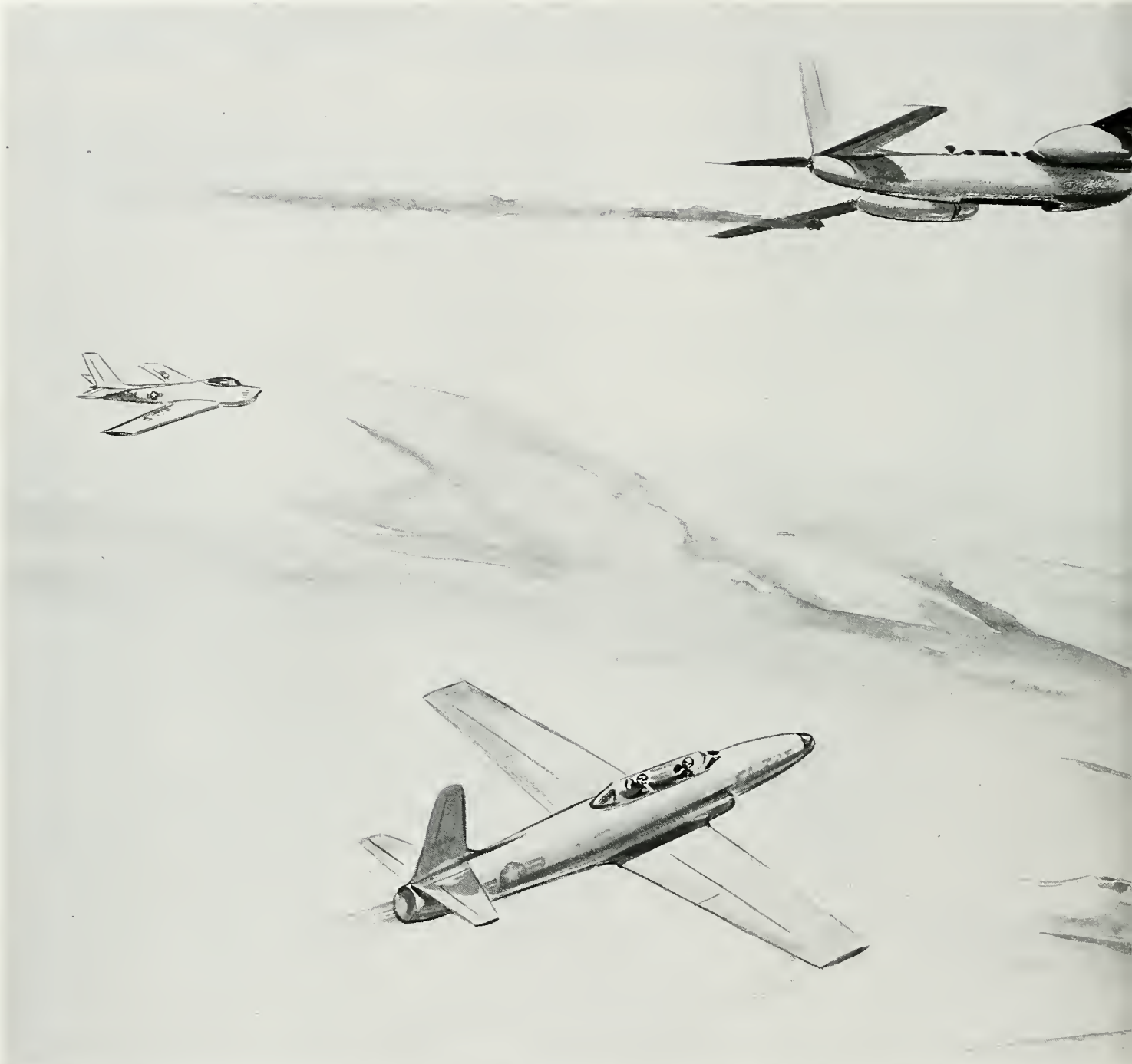
Although the new J-40 is two and one half times more powerful than the combined four engines of a B-29 Superfortress, its weight, approximately 3,500 pounds, is less than that of only one of the B-29's engines and propellers.

Frank L. Snyder, manager of the Westinghouse Aviation Gas Turbine Division, Philadelphia, Pa., revealed that still more powerful versions of the J-40 are being developed.

In development of the new J-40, large quantities of two of the nation's most critical metals, columbium and cobalt, have been eliminated. As this engine is constantly improved, still greater savings of scarce materials are anticipated by Westinghouse engineers and metallurgists.

New model of Westinghouse J-40 turbojet engine develops thrust equivalent to approximately 25,000 horsepower at today's jet flight speeds. It has passed severe tests.





Ryan Q-2, pictured in artist's sketch at instant of release from B-26, is pursued by T-33 phata plane, foreground, and F-86 chase pla

Q-2 AWAY

Tracking the Ryan pilotless jet plane takes high-speed te

in distance at left.

IN a few seconds it will be "X" minus five minutes.

Half an hour ago Capt. John J. Binkley and the crew of the twin-engine launch plane had taken off from Holloman Air Development Center near White Sands, New Mexico on another mission to flight test the Ryan Q-2 target drone, now snugly fitted into the bomb bay of a Douglas B-26.

In a mobile control van somewhere on the 38-by-64 mile desert test base, Capt. John Richards, the Air Forces' Q-2 project officer, is at the remote control panel. His civilian counterpart, Mickey McDaniel, Ryan flight test supervisor, is at the VHF voice radio, and both are huddled around the plotting board.

Aboard the B-26 the direct control operator of the Q-2 jet-propelled pilotless target plane today is T/Sgt. Bob Faraci. From take-off until launching he will have control of the target through an umbilical cord. At "X" minus seven minutes the sergeant has started the small but powerful jet engine of the "captive" target after checking out all controls. Now the functioning of the remote control system is checked by Faraci as the buttons and "stick" at the ground station are operated by Capt. Richards.

At five minutes before launching, McDaniel's voice comes in clear over the B-26 radio. *"Change target power from external to internal source."* A minute later, as McDaniel calls out *"X minus four minutes,"* Faraci also changes over the telemetering power from external to internal.

At two minutes before launch time, Faraci turns on the tracking smoke which billows out from the left wing of the B-26 so ground observers may locate mother plane and target at the launching altitude.

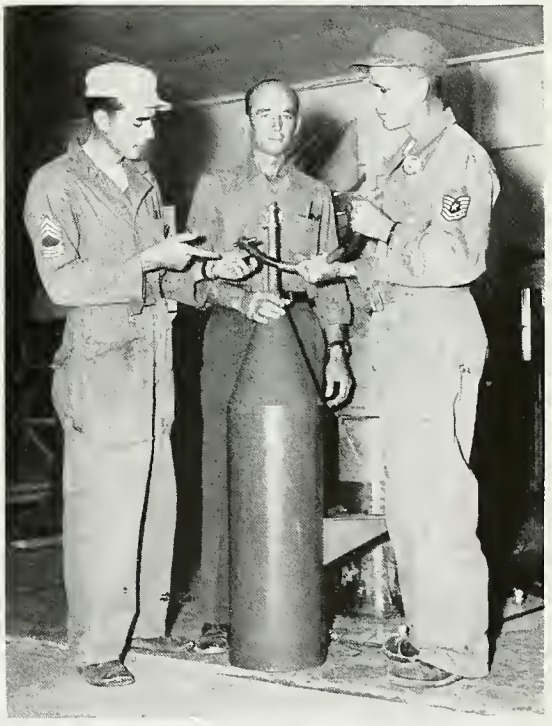
"Minus ninety seconds," McDaniel announces. *"Extract starting power umbilical cord."*

"Minus forty-five seconds: Launch plane, assume straight and level attitude. Announce outside temperature, airspeed and altitude."

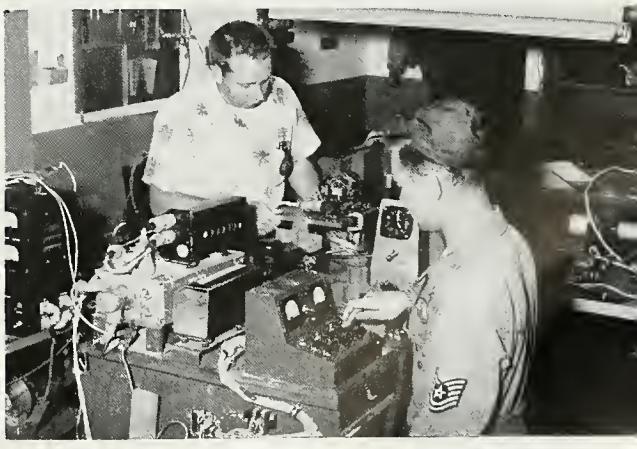
"Minus forty: Uncage gyros. Adjust target plane elevator settings."

(Continued on page 24)

Getting cued on the Q-2 at this conference of Ryan and Air Force personnel are, left to right, Bill Fisher, civilian project engineer; J. M. Moore, of Wright Field; Second Lt. Dave Gleason; Mickey McDaniel and C. D. Burkholder, both of the Ryan staff.



Test mechanism is checked by M/Sgt. Owen Severns, N.C.O. in charge of enlisted personnel; G. C. Hammett, shop foreman; and T/Sgt. Earnest Griffin.



Autopilot system is checked out with control box by William Berry, autopilot engineer, left; and T/Sgt. John Shelton.

EXTRA SENSORY PERCEPTOR

RYAN has designed a new, ultra-sensitive control which will automatically maintain velocity, acceleration, altitude, temperature, pressure, humidity or almost any other condition within extremely close limits. Perfected in response to the need for a compact flight control for testing Ryan aircraft at high speeds, the unique device will have hundreds of other applications because of its special features.

It is completely positive in operation, is practically unaffected by vibration and change in temperature and, most important, it will respond to the smallest measurable changes in environmental conditions without detracting from the sensitivity or accuracy of the monitoring instruments.

A product of the Ryan development laboratories, the new control is the accomplishment of Win Alderson and Douglas

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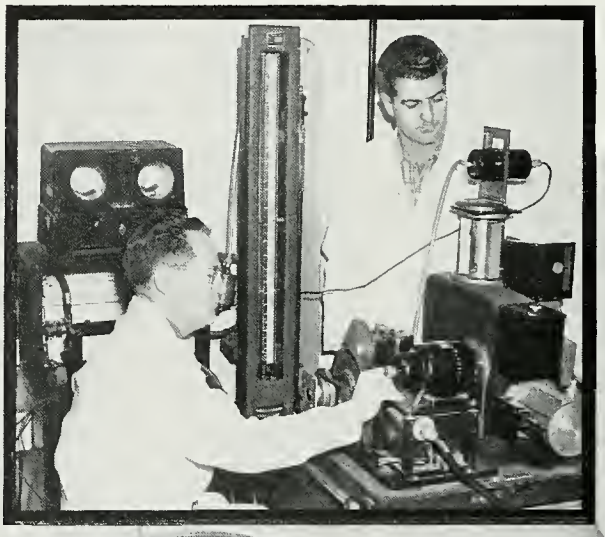
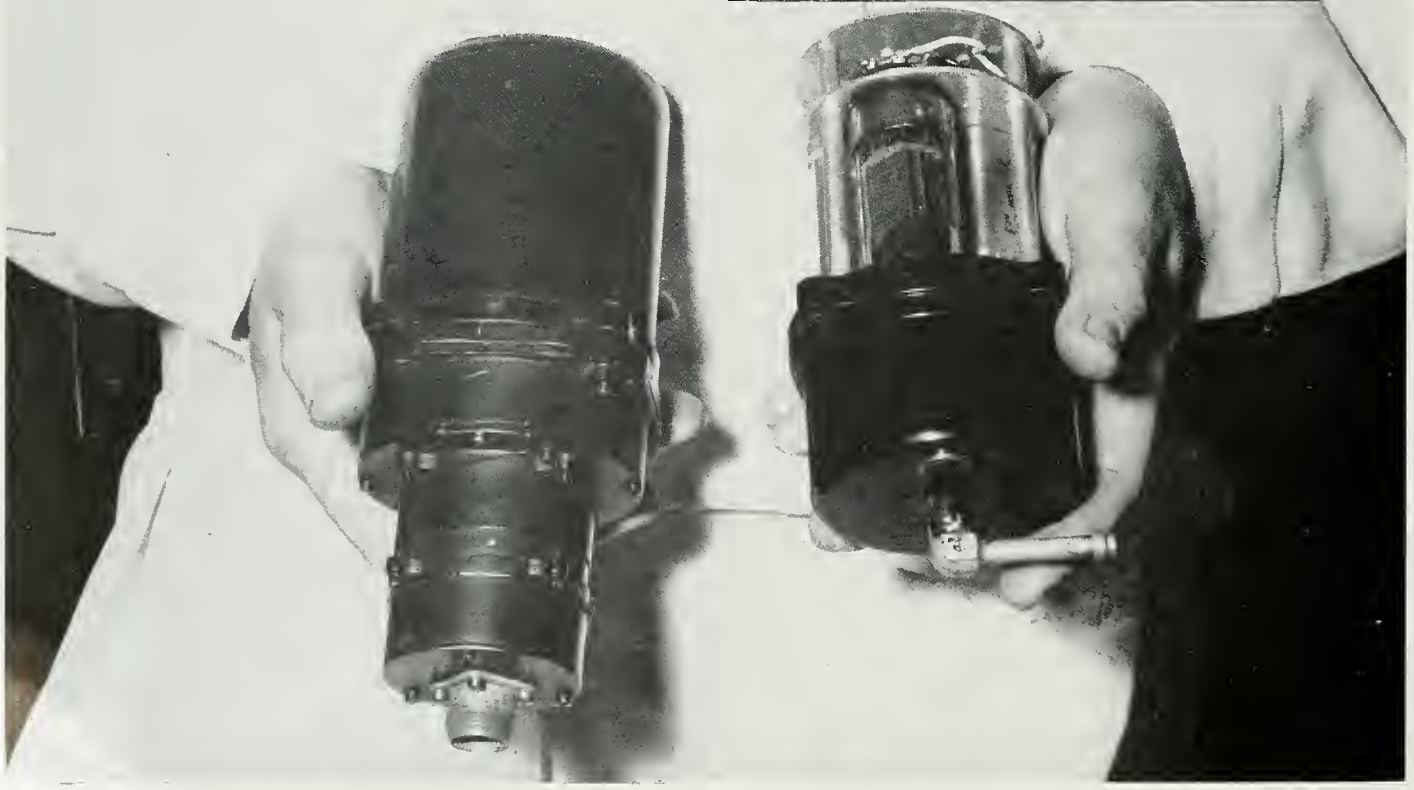
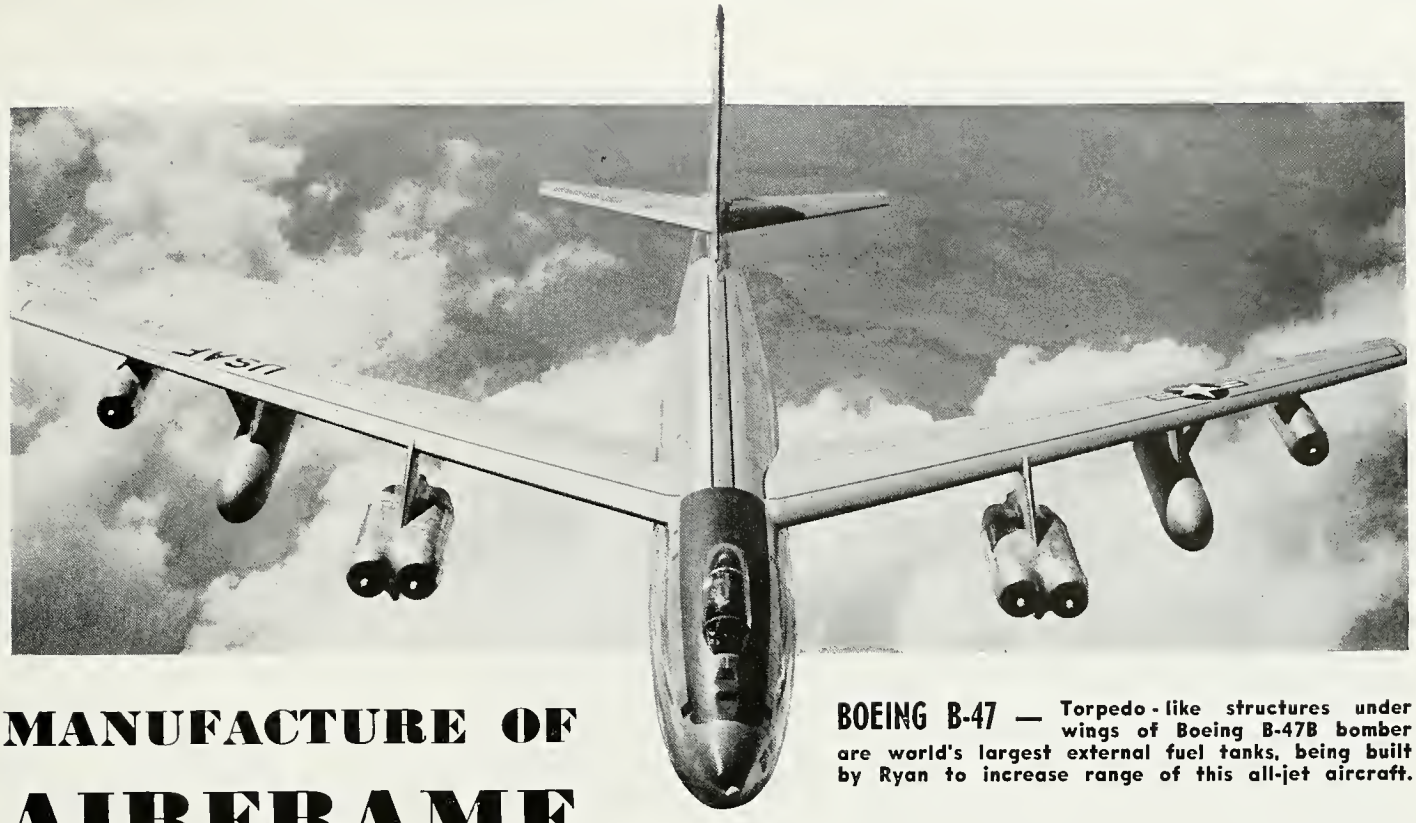


Vibration shake-down test is given Ryan's new sensitive control by developers Win Alderson and Douglas Erickson (right). Two of many applications are with tachometer and air speed indicator (shown below) to control engine speed and aircraft velocity.





BOEING B-47 — Torpedo-like structures under wings of Boeing B-47B bomber are world's largest external fuel tanks, being built by Ryan to increase range of this all-jet aircraft.

MANUFACTURE OF AIRFRAME COMPONENTS

RYAN versatility is best exemplified by the variety of aircraft components which the company has built for other manufacturers. Many of these orders involve exacting structures which must be fabricated to precise specifications to mate with components made or assembled in plants thousands of miles away. In other instances, the purchaser outlines the basic requirements for the particular component and requests Ryan to design it as well as build it. This entails a complete engineering service from initial design to final testing.

Best illustration of the latter class of component is the huge Ryan fuel tank. About two years ago, Boeing Airplane Company requested Ryan to assist in design of a new external wing fuel tank which could carry unprecedented gallonage to extend the range of the B-47B Stratojet bomber. With their request they supplied basic information concerning desired capacity, the contours of the tank and design details of the struts for connecting the big containers to the underside of the Stratojet's wings. With this beginning, Ryan engineers went to work.

They created a huge torpedo-like structure which is the largest external fuel cell built. Cylindrically-shaped, with tapered nose and tail domes, the mammoth container is remarkably light in weight because of several Ryan innovations. First, it was designed to take full advantage of the benefits of electric spot welding—a long-time Ryan specialty. It is put together with 30,000 spot welds which are weightless and which present no protuberances to air flow because they are within the aluminum alloy sheets themselves. Special spot welding machines, the largest of their type, had to be designed and built to handle the record-breaking dimensions of these new tanks.

Second, substantial weight was saved by the elimination of all longitudinal members, usually found in large fuel tanks, and the use of few bulkheads. These innovations were made possible by the exceptional strength of the design and the integrity of the spot welding procedure.

The tanks are proving successful not only in the application for which they were originally designed but also in another pioneering project. Permanently affixed to the wings of the Fairchild C-119H, newest member of the "flying boxcar" family, these tanks are used to carry the entire fuel supply, externally. By moving the fuel out of the C-119H's wings, twenty-two internal fuel cells have been eliminated, with a saving in weight of 600 pounds. Also, fire hazard and maintenance requirements are materially reduced.

Undoubtedly the largest components which Ryan has built, both in size and value, are fuselage sections for Boeing C-97 Stratofreighters. Comprising the aft section of the Stratofreighter's fuselage, these big aluminum alloy structures

(Continued on next page)

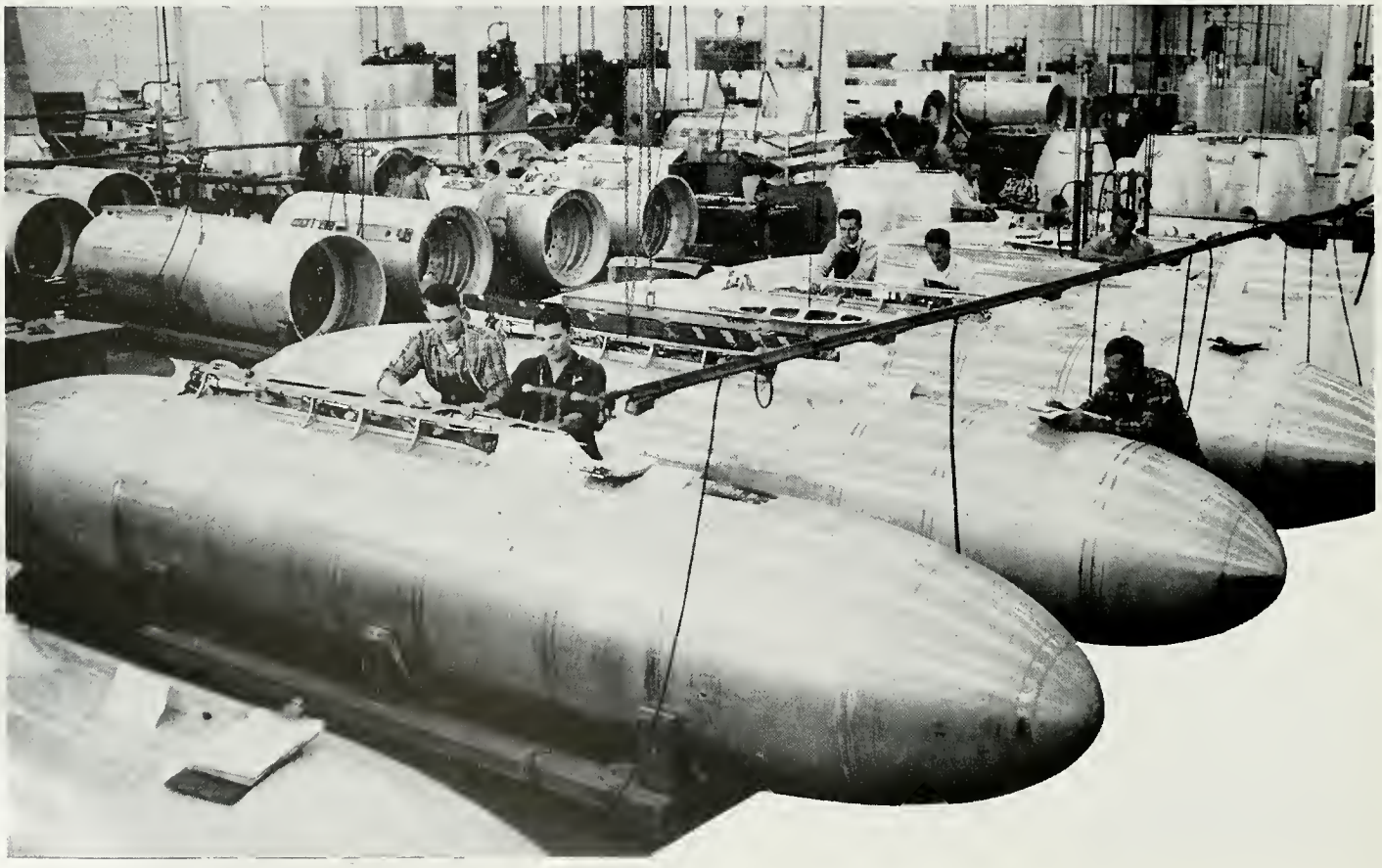
REFUELING PODS — Use of Boeing Stratofreighters as aerial tankers for midair refueling was made possible by construction at Ryan of pod in fuselage for operator and refueling boom. Pods replace cargo doors, also Ryan-built.

are pressurized and flush-riveted. The C-97's are equipped with clam-shell type loading doors and retractable ramps. Cargo can be loaded through the bays with self-contained electric hoists. Trucks, light tanks and artillery can be rolled up the ramps under their own power.

In manufacturing large numbers of the sections, Ryan had to develop accurate tooling and maintain extremely close precision so that the aft sections would match perfectly with the Boeing fuselages in Seattle, Washington.

In 1950 the Air Force added a new role to the Stratofreighter's versatile repertoire—that of an aerial tanker for mid-air refueling. With great urgency the plans for this conversion were started at Boeing and began to flow to Ryan through interlocking engineering, production and tooling departments. The project was taken on so fast that detail tools were being made in San Diego before Ryan had 15 percent of the total engineering information from Boeing. This unorthodox overlapping of sequences saved extensive periods of time and, due to extremely close coordination,

LARGEST FUEL TANKS — Bigger than fuselages of some private planes are these external wing fuel tanks being produced at Ryan for Boeing B-47 bombers. Similar tanks are used for new Fairchild C-119H cargo transport.



the tools produced were as accurate as those built under normal circumstances.

Working between 65 and 70 hours weekly, Ryan fuselage employees tooled up for the production of a pod unit. Containing the station for the refueling boom and operator, the pod is slipped into the loading bay in place of the cargo doors and attached to the door hinges. From this unit, the refueling boom operator, who is in communication with both planes during the critical fuel transfer period, directs the operation. Converted Stratofreighters have successfully refueled Boeing B-47 Stratojets, B-50 Superfortresses, North American F-86 Sabrejets, Republic F-84 Thunderjets and other prominent aircraft in flight.

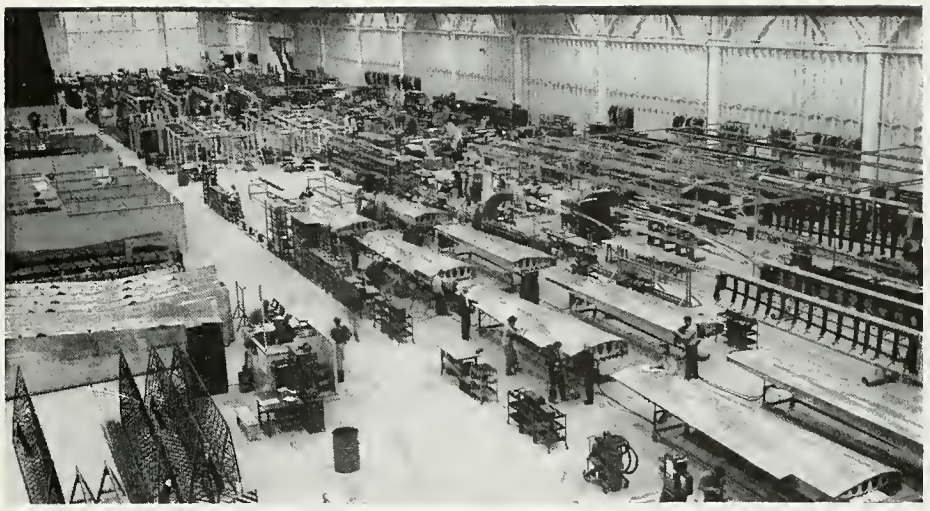
Ryan also builds all of the floor beams used in Boeing Stratofreighters. Patterned after structural steel "I"-beams, these aircraft members are extremely strong yet light in weight. A thousand spot welds are used to form them. Forty-nine Ryan floor beams support the weight of 68,000 pounds of cargo which each Stratofreighter can carry.

Ryan began building aircraft components in 1942 after completing the production of hundreds of the famous PT-22 low-wing trainers — World War II's popular primary training plane. First components were major structures for a new scout observation plane Ryan was to build under contract with the U. S. Navy — the SOR-1, based on a Curtiss-Wright design. Also, in 1942 Ryan produced substantial numbers of stainless steel firewalls for the Lockheed "Hudson" medium bombers which saw service in Australia in anti-submarine patrol work.

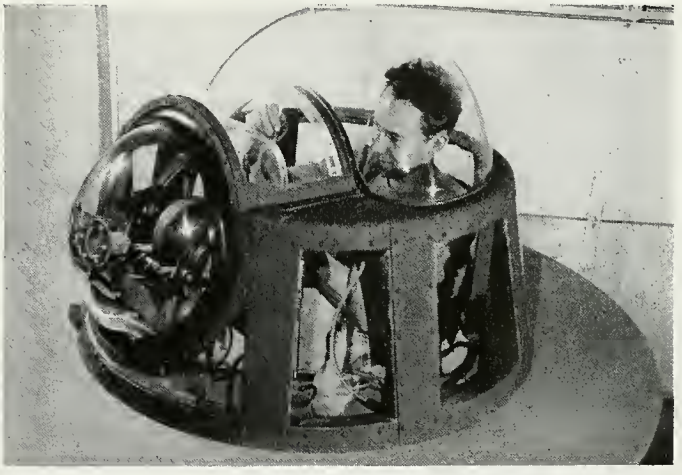
In 1943, the Consolidated B-24 heavy bomber was making its presence felt in the skies over Europe and Ryan was building several major components for the B-24 assembly lines. The large outer wing panels, elevators, rudders and ailerons were flowing from Ryan in impressive volume in this period of production for war.

Another specialized product which Ryan turned out to meet the needs of wartime was the .50-caliber, twin-gun turret. Required to arm Consolidated PBY-5 "Catalina" flying boats, these plastic-domed gun turrets contained all of the equipment for the comfort and efficiency of air-borne machine-gunners.

Since these early beginnings, Ryan has continued to build aircraft components for other manufacturers in addition to the other phases of fabrication pursued. Today, this division accounts for an important share of the total production of the company.

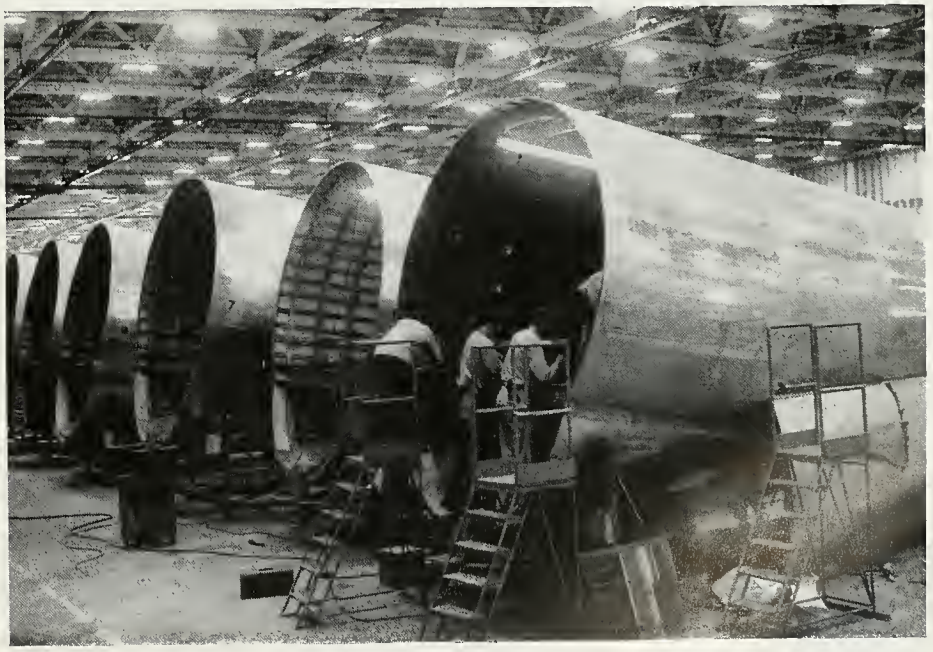


WINGS — Outer wing panels for one of World War II's mightiest planes, the Consolidated Vultee Aircraft Corp. B-24, were built in large quantities by Ryan, which also produced elevators, rudders and ailerons for this 4-engined bomber.



GUN TURRETS — One of major aircraft components produced by Ryan during World War II was plastic-domed turrets for two .50-caliber guns used to provide protection for Consolidoted Vultee's versatile PBY-5 Catalina flying boats.

C-97 FUSELAGES — These fuselage sections for Stratofreighters are largest aircraft components Ryan has built. Fabricated of aluminum alloy, they comprise aft section of fuselage, and are pressurized and flush-riveted.



EXTRA SENSORY PERCEPTOR

(Continued from page 16)

Erickson, laboratory analysts. With it, Ryan engineers can automatically maintain the speed, altitude or direction of fast-flying, uninhabited missiles and aircraft. It could be used to automatically raise and lower landing gear or flaps at specified altitudes or open and close engine cowl flaps, to mention only a few aircraft applications. In other fields, its usefulness is almost unlimited.

The control is contained in a small, cylindrical case 4 inches long and 3 inches in diameter. In it there are two tiny electric lamps, placed immediately adjacent to each other, a photoelectric cell, a vacuum tube amplifier and a sensitive relay. The lamps are located behind a metal shield in which a small window has been cut. Through this opening, the light from the lamps can pass to impinge on the photoelectric cell.

For use with rotating pointer instruments, such as air speed indicators, altimeters, tachometers or pressure gauges, the control is made to attach to the case of the instrument. One simple modification is made to the instrument. A small, counterbalanced metal flag is substituted for the instrument pointer.

The control is attached to the case of the measuring instrument in such a way that the movement of the flag can obstruct the light from the lamps by passing in front of the window. In operation, one of the lamps is switched on and its light is projected through the window to the photoelectric cell. The cell generates an electric current which is amplified by the vacuum tube and the signal actuates the sensitive relay to perform the task required.

As the measured conditions change, the instrument staff rotates and brings the flag to a stop, in front of the two lamps. Thus, the light from the single lamp that is burning is obscured, the current from the photoelectric cell is cut and the relay is actuated. The relay switches on the other lamp which is also obscured by the flag. As the measured conditions begin to reverse, the flag rotates in the opposite direction and allows the light generated by the second lamp to strike the photoelectric cell. Again, the cell is stimulated, the relay is actuated, the second lamp is extinguished and the first lamp is turned on.

In this way, the control will operate within a predetermined differential in condition as measured by the instrument. By varying the distance between the two lamps and the size of the flag, it is possible to obtain extremely sensitive perception of this differential by the control. To change the range of the control, it is necessary to merely rotate the control in the instrument.

Because there is no mechanical linkage between the instrument and control, the device cannot detract from the instrument's sensitivity or accuracy in the slightest degree. This is particularly beneficial in cases where very slight changes are being measured. For instance, the control is practically the only type which will respond to pressure changes of only one-tenth of an inch of water, or about the pressure of a normal exhalation of breath, without affecting instrument accuracy.

ANOTHER valuable characteristic of the Ryan device is its positive action. It has been designed so that oscillation of the instrument will not affect the positive action of the control nor cause intermittent response.

The Ryan development laboratories have tested the control to determine its behavior under conditions of varying temperature and vibration. Over a temperature change of 189°F., the accuracy of the device was affected less than one-tenth of one percent. Under vibration tests, with 55 cycles at .030" amplitude, the control was accurate within a two percent margin.

Other advantages of the control are ruggedness, simplicity and inexpensive cost of fabrication. It does not require a high voltage power source but will operate on standard 24 volt D.C. current. Ryan is patenting the design.

Looks Us Over!

H. W. Chandler, production manager of General Electric's huge jet engine division at Evendale, Ohio, inspects afterburner for J-47 engine in Ryan plant with L. M. Limbach, Ryan works manager.

AFT FRAMES

(Continued from page 7)

Welding quality requirements are high. The large circumferential welds must be accomplished, manually, with weld widths controlled within 1/16 inches and parent metals penetrated to at least 20 percent of thickness.

Special welding problems are posed by the widely varying thicknesses of the metals being joined. Seams are made between metals with such difference in thickness as 1/16 inch to 3/8 inch. This requires extra care in order to obtain correct penetration into the metals and to prevent undue distortion and cracking caused by the different rates of heat dissipation.

Because they are large, contain many mating surfaces and incorporate close dimensions, the aft frames require a record-breaking number of machining operations. Most surfaces must be finished to a smoothness of 63 RMS microinches. Drilled and tapped holes have to be centered within .010" of true location. Concentricity and squareness specifications demand that specified surfaces must be perpendicular to others within .0003 inch per inch. Certain diameters are held within a plus or minus .001".

These extensive machining operations have necessitated the use of an array of large, expensive machines which are the most elaborate that Ryan has ever assembled for a production project. Substantial numbers of vertical turret lathes, gap lathes, radial arm drills, boring mills, multiple drilling machines and tapping machines are employed as well as a number of specially-designed, single-purpose tools.

To machine, automatically, three large flanges in one set-up, Ryan has installed a unique Excello boring machine which has been designed and built for this particular task. The most expensive single-purpose machine in the plant, this $65,000, 20-ton tool takes only fifteen minutes to perform the machining which would otherwise require four hours. With three separate heads, equipped with 13 carbide-tipped cutters, the giant goes into action at the press of a push button. While the aft frame remains firmly clamped, the cutting heads rotate and move into the work to machine both end flanges and the interior bearing housing. Concentricity of the machined surfaces is held within .002".

One of the difficult machining assignments for production of the aft frame was the cutting of the eight combustion chamber eyelets which rim the burner plate. These flanges require boring, turning, facing and undercutting within

(Continued on next page)

tolerances of .005". To do this work on boring mills would have taken two days per frame and tied up costly machines. Ryan devised a special boring fixture, powered by standard radial arm drills, which accomplishes the work in two to three hours. Containing four sets of rough and finish cutters, these fixtures make a series of eight machining operations in one continuous sequence without supervision.

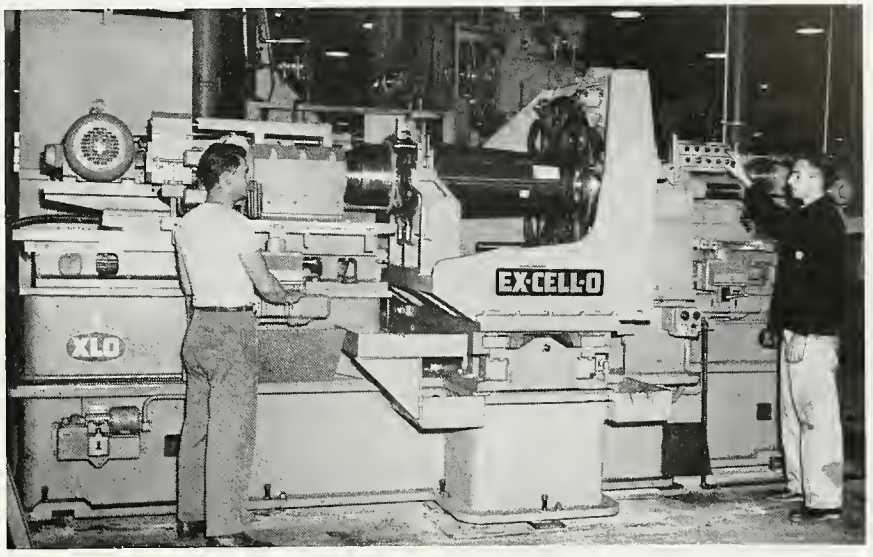
Another interesting machine tool which saves countless hours of production time is the new Natco multiple-spindle drilling machine which Ryan uses to drill the 160 precision bolt holes in the burner plate, adapter flange and bearing housing. Dwarfing all other drilling machines at Ryan by its size and power, this behemoth cuts a three hour drilling job down to 15 minutes. Powered by a 25-horsepower electric motor, the big Natco drills forty holes at a time.

After machining, the aft frames are cleaned of all chips, turnings and other extraneous material by vibration. They are clamped to a base which is fitted with two cylinders and oscillating pistons actuated by compressed air. The frames are vibrated at high frequency to shake out all foreign matter. Soil and grease are removed by immersing them in a trichlorethylene vapor bath.

AN essential part of the production procedure for building aft frames is heat treating. Substantial amounts of residual stress are locked up in the components as a result of the extensive forming, welding and machining which they undergo. To remove these stresses, the aft frames are heated, electrically, in a closed General Electric furnace. Heating and cooling cycles are carefully regulated for a 16-hour period to remove all traces of tension so that the structures will maintain perfect alignment in jet engine service. The furnace is fed a controlled atmosphere to prevent oxidation of the hot metal during the heat treating process.

After completion, the aft frames are shipped from Ryan to the General Electric Company plant at Evendale, Ohio. Here, they are mated with other Ryan-built assemblies, such as combustion chambers, afterburners, exhaust cones and transition liners, and assembled into J-47 jet engines.

General Electric has devised a novel method of assembling the engines in a vertical position. This provides for better alignment of the 12-foot long jets by avoiding even slight sag in the components due to weight. It saves a good deal of valuable floor space and permits faster assembly of the units because more of the engine is accessible to work on.



MAGIC MILL

The most expensive single-purpose machine tool at Ryan is a unique, new Excello boring mill which is used to machine aft frames for General Electric J-47 jet engines. Especially designed for this task by Excello Corporation of Detroit, the $65,000 mechanism performs more automatic machining operations than any other Ryan tool.

It takes only one man to load the aft frame into the machine and press a push-button. From then, the complex tool automatically machines the forward flange, stiffener bearing flange and aft bearing housing in one continuous sequence. At the end, the machine returns to its original position and shuts itself off. In fifteen minutes, it does the work which formerly required four hours by other machine tools.

In addition to the sizable time savings effected, the new boring mill provides greater accuracy in the work. Contract requirements demand that the large flanges of the aft frames be exact and concentric. Some diameters must be held within plus or minus .001 inch and concentricities limitations run as high as .005 inches. Parallelism is restricted to .0003 inches per inch. In a large stainless steel structure this is a difficult responsibility to assume on a production basis.

The new Excello meets these demands because its design permits the entire machining sequence of the three flanges while the part is firmly held in a stationary position. Only one set-up of the aft frame is required for the 13 machining operations. Discrepancies caused by faulty alignment of the part between operations are completely avoided.

In operation, the aft frame is loaded into the 20-ton boring mill by means of an overhead crane and air hoist. The part goes into a special cradle and a line-up plug is inserted into one end of the aft frame to insure its perfect alignment. The small end of the component is clamped with a steel bracket and the line-up plug is retracted. At the press of a push-button a series of hydraulically actuated clamps automatically swing around to clamp the large burner plate section in place. Microswitches on both the bracket and line-up plug prevent starting of the machine until the aft frame is properly clamped in position. The operator then presses the cycle push-button and the machine takes over in an automatic procedure.

First, the cutting head, to the left, moves into the part and bores and faces the forward flange. At completion, it retracts and the entire cradle assembly slides sideways to bring the aft frame into line with two other cutting heads. They move into the work, from opposite ends, and one head bores, counterbores, chamfers and faces the stiffener bearing flange which is inside the barrel of the aft frame. The other head bores, counterbores and faces the aft bearing housing, from the other direction. When this is done the heads retract and the cradle returns the part to the front of the machine.

The three cutting heads which perform the machining are equipped with 13 tungsten carbide tools and are powered by individual 5-horsepower electric motors. Each moves into the work on steel guides under hydraulic pressure. In each head, an ingenious cam operated mechanism retracts and extends the various cutting tools to perform the different machining operations in a carefully controlled sequence of timed operations.

Top Ceramic Expert Sees Ryan Projects

America's top expert in the field of industrial ceramics recently paid his first visit to Ryan since this company began its pioneering application of such coatings to the "hot spots" of exhaust systems.

He is W. N. Harrison, who has been chief of the enameled metals section of the National Bureau of Standards more than 22 years. His section has been responsible for developing ceramic coatings which have been, and are being used extensively in the aircraft industry.

CERAMICS EXPERTS—W. N. Harrison (seated), chief of the enameled metals section, National Bureau of Standards, recently conferred with left to right, standing, Wilson G. Hubbell, W. S. Cockrell and Al Pechman, on Ryan's ceramics program.

Harrison expressed enthusiasm over Ryan's role in ceramics, and predicted widening use of such protective coating to extend the life of metals and to permit replacement of strategic metals with lower grade alloys.

At Ryan, he conferred with T. Claude Ryan, president; W. S. Cockrell, chief of the development laboratories; Wilson G. Hubbell, assistant chief; and Al Pechman, ceramics engineer.

Through the National Bureau of Standards, the industry is being further acquainted with Ryan's work in ceramic coatings. A large quantity of the company's recently published and widely acclaimed brochure, "Facts About Ceramic Coating," now in its second printing, has been provided the Bureau for distribution to persons from whom inquiries are constantly being received about this process.

GLOBAL LIAISON

(Continued from page 2)

service representatives are relied upon to bring into the field, without delay, the data accumulated in metallurgical research and fabrication. Longer, trouble-free service life for Ryan exhaust systems is the goal.

"Whenever a problem arises at a maintenance and overhaul base, we can be there within 24 hours," says Foushee.

"And wherever new equipment is being placed into service, we go there as a matter of course."

A typical service tour will keep Foushee away from home-cooked meals for a month or more. Here's a typical itinerary:

From Ryan's plant in San Diego to Los Angeles, to Western Air Lines' base for maintenance and overhaul of DC-3's, DC-4's and Convair 240's. Then to San Francisco, where United Air Lines and Pan American World Airways are conducting test programs on Boeing 377 Stratocruisers. A side trip to Moffett Field is necessary to check with the Navy, which is using the R6D-1, equivalent of the DC-6A.

Next stop Denver, where Continental Air Lines services 240's. Tulsa follows. Maintenance of exhaust systems on DC-6's and Convair 240's by American Airlines personnel occupies Foushee.

In St. Paul, Minnesota, he checks on Northwest Airlines' Stratocruisers and DC-3's and DC-4's, and on Mid-Continent Airlines' DC-3's and 240's.

He hops next to New York for a look-see into techniques of British Overseas Airways Corporation and Pan American in Stratocruiser maintenance. Then a swing up to Boston for conferences with Northeast Airlines, using Convair 240's.

Heading south, Foushee stops at Washington, where Capital Airlines maintains its DC-4's and DC-3's; and at Miami, Fla., where he meets again with Pan Am crews on the Stratocruiser and the 240, as well as Eastern Air Lines for the DC-4, and National Airlines for the DC-4 and DC-6. National also has facilities at Jacksonville, necessitating a stop there.

In Atlanta, Foushee looks over work on Delta Airlines' DC-3's, DC-4's and DC-6's. On to Memphis where Chicago & Southern Air Lines has its base for DC-3's and DC-4's, and Dallas, where Braniff operates DC-3's, DC-4's and DC-6's.

Up in Dayton, Ohio, Foushee has appointments with Air Materiel Command headquarters personnel in the power plant and maintenance sections concerned with the B-50 and the various transports, the C-47, C-54, C-74, C-97, C-119 and C-124. He fits these in to his rigorous schedule, and in addition stops at Air Force overhaul and maintenance bases through the South and Southwest. These include the Warner-Robbins Air Force Base in Georgia, Brookley Field, Mobile, Alabama, and Davis-Monthan Air Base at Tucson, Arizona, where some of the largest reciprocating engines in use today are overhauled.

Home with a fistful of notes, Foushee goes into a prolonged huddle with engineering, fabrication and research people at Ryan to inform them what their product is doing in the field and to pass along ideas of the airline operators that might have an effect on factory processes.

The world wide scope of Ryan exhaust systems usage has led to important overseas assignments.

During the Berlin Airlift, the Air Force virtually "drafted" Foushee to help supervise the servicing of exhaust systems at bases throughout Germany and England. Shortage of equipment and constant turnover of personnel in the face of the most tremendous pressure ever placed on a transport organization over an extended period of time made the job tough. But the Ryan exhausts matched the challenge with a toughness of their own as the big planes, primarily C-54's, defied weather, wear and tear and German Reds to keep Berlin from starving to death.

Before returning to San Diego, Foushee toured the maintenance bases of the major foreign airlines using DC-3's, DC-4's, DC-6's and Convair 240's — B.O.A.C. in England, Sabena in Belgium, KLM in Holland, and Swissair in Switzerland, providing the same service given airlines in this country.

Later, Foushee made a special trip to England to confer with B.O.A.C. officials on maintenance of exhaust systems in the airline's transatlantic Boeing Stratocruisers.

More recently, another Ryan service representative, Gilbert M. Hansen, was called to Japan on assignment to the 374th Troop Carrier wing at Tachikawa Air Force Base, as an advisor on the proper maintenance and installation of

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GLOBAL LIAISON

(Continued from page 22)

Ryan exhaust systems in Douglas C-124 Globemaster transports.

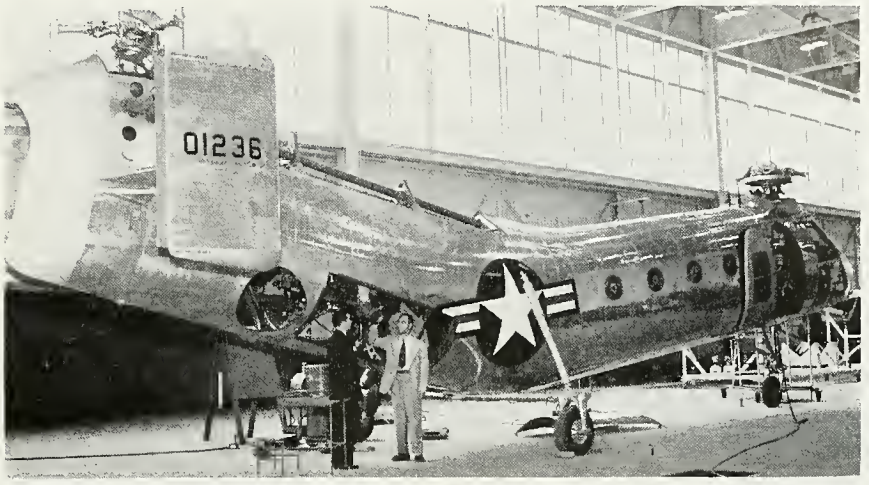
The task of maintaining these giant planes in the Korean conflict is made extremely difficult because of the many uses to which these planes are put. Not only are they constantly shuttling between Japan and Korea with wounded men, supplies, equipment and damaged aircraft brought to Tachikawa for repairs, but they are used for training and transition flying, which is considered particularly hard on any aircraft.

At Tachikawa, which during World War II was the "Wright Field" of Japan, Hansen worked with Air Force ground crews and Japanese mechanics in the large maintenance shops, during an intensive 15-day period. Not only did he bring to Japan the benefit of factory knowledge, but he acquired information on operating conditions that will prove of value to Ryan's engineering and production departments.

Besides determining what can be done to improve service life, Ryan's field representatives assist the airlines and the military in establishing closer control over maintenance and overhaul procedures. Another beneficial result is the development of new production techniques. As a result, Ryan has in recent years become a leader in the adaptation of ceramic coating to the "hottest" parts of exhaust systems, thereby prolonging service life. Pioneering has also occurred in the use of various combinations of metals for most effective application to today's high-temperature, high-horsepower engines.

The nation's leading transport manufacturers, such as Boeing, Douglas and Convair, depend on Ryan for the servicing of exhaust systems. Coordination of information in the field is achieved on the spot in conferences with representatives of the airframe producers, and through a constant flow of data to the headquarters of the manufacturers.

It isn't just "book knowledge" the Ryan service representatives bring to the airlines and the Air Force. Like Foushee, most of them started as workmen in the factory, and showed such adeptness that they were called into customer service. They learned about exhaust systems by building them. Now they're channeling information in two directions—from the factory to the airline to improve maintenance and overhaul, and from the airline to the factory to improve production techniques.



Shroud and outlet section of a Ryan-built exhaust system in giant YH-21 helicopter is inspected by two Ryan officials, C. L. Foushee and John M. Cameron.

Ryanites Confer at Helicopter Plant

Two Ryanites held important conferences recently at booming Piasecki Helicopter Corp., one of the country's fastest growing aviation enterprises.

They are C. L. Foushee, Jr., manager of the Ryan service department, customer service; and John M. Cameron, supervisor of final assembly inspection.

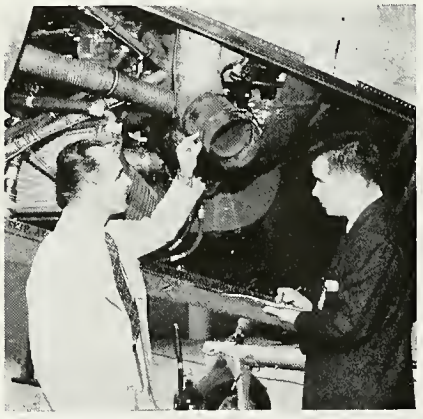
At Piasecki, they met with that company's officials to coordinate production problems on the large quantity of helicopter exhaust systems being produced by Ryan.

Piasecki's spectacular rise to eminence in its field as a post-war concern has been observed with particular interest at Ryan because since the early development of Piasecki helicopters, Ryan was chosen to provide high temperature exhaust equipment. Close liaison between the two plants has been constantly maintained.

Ryan is in quantity production of manifolds for the Continental R-975, 525 h.p. engine used in the Piasecki HUP, and for the Wright R-1820, 1425 h.p. engine which powers the giant YH-21 helicopter.

These are radial, air-cooled engines which are buried in the central part of the helicopter close to the centers of gravity. Ryan also makes special lightweight stainless steel shrouds, used as firewalls on the HUP and to cool the collector stacks. In the YH-21, the shrouds also collect heat for use in preventing icing of the carburetor.

Considered one of the country's foremost experimenters in the application of titanium to aircraft parts, Ryan's earliest work with this difficult metal featured assembly of an exhaust system shroud for the HUP-1.



Coordination of production problems on exhaust systems is made possible by such visits as those made to Piasecki by Cameron, left, and Foushee.

Spectacular rescues have been performed in waters off continental United States by Piasecki helicopters. Now the YH-21, capable of transporting as many as 27 persons in emergency rescue work, can also serve as a troop transport on combat missions. It is "omniphibious," capable of operating from snow, ice, water, tundra, marsh and land by means of specially devised gear which combine wheels, floats and skis.

Ryan-equipped Piaseckis are used today by Air Force, Navy, Marine and Coast Guard units.

Titanium Experts Visit

Experts from aircraft plants throughout the west met recently at Ryan for a meeting of the western region aircraft research and testing committee of the Aircraft Industries Association.

Of particular interest was a report given by Major R. J. Kotfila (right), Wright Air Development Center metallurgist; and Dr. H. K. Adenstedt (center), chief of the titanium section of Wright A D C, on the titanium research and development program sponsored by the WADC, Dayton, Ohio. After the meeting, they conferred with Wilson G. Hubbell (left), assistant chief of Ryan development laboratories.

Ryan is one of the leaders in this program, at present conducting special work for the Air Force and the Navy in the application of titanium to exhaust systems as well as airframe components. Ryan was one of the first companies in the nation to form titanium successfully by the drophammer process.

Q-2 AWAY

(Continued from page 15)

In the F-86 "chase plane," Capt. Paul Williams, Chief of the Pilotless Aircraft Sub-Unit at Holloman, moves the stick over gently as he brings the Sabre into formation below and to the left of the launching aircraft.

"Minus fifteen: Turn off external power at direct control box. Get ready to start recording cameras."

On the other side of the launch plane, a T-33 photo plane flown by Lt. Bob Hazlett also swings into formation. T/Sgt. Bill Barnes, photographer in the rear seat, gets set to start recording today's test flight on film.

There's an air of tenseness in the planes up there above Holloman, and at the ground stations, too, as McDaniel starts the final countdown.

"Minus ten seconds . . . nine . . . eight . . . seven . . . six . . . five . . . four . . . three . . . two . . . one . . . DROP."

Back from Faraci comes the word, "TARGET CLEAR."

Immediately Capt. Binkley executes a sharp climbing turn to the right which takes the launch plane out of the test area.

As the Q-2 target streaks away on its own, accelerating rapidly toward sonic speed from the 210 mph launching speed of the B-26, the center of interest changes to the two jet fighter chase planes and their crews.

At X minus two seconds Barnes had started his cameras to be certain to get a shot of the separation of the Q-2 as it drops away from the belly of the launch plane. Lt. Hazlett concentrates on following the drone, maintaining his position in the three-plane formation, so that Barnes may continue to record the flight attitude of the target aircraft as long as he has film. The photo plane will remain in the area until the end of the flight in order to photograph the recovery of the target.

Williams in the F-86 meanwhile begins his running commentary to the remote control position, constantly reporting on the behavior of the drone which is now being operated by Capt. Richards at his "black box" which controls flight maneuvers, engine speed and the recovery system. Should the drone get out of control, Williams need only ask Richards to start the Q-2's automatic parachute recovery system which lowers the target safely to the ground after each flight.

Inside the mobile van neither Richard nor McDaniel can see the Q-2, now far beyond sight, but the plotting board shows the target's path and altitude and Williams is up there as a trained observer to check the "bird's" performance. At the same time, too, the Q-2's telemetering equipment is sending, via FM radio, information on airspeed, altitude, elevator and aileron position, engine speed, exhaust gas temperatures, etc., to the ground telemetering station which picks up and records the data on film for later interpretation.

Today's test is to determine the angle of attack which gives the best rate of climb at high altitude and to observe operating characteristics of the drone's jet engine above 20,000 feet.

Outside the mobile control van, two operators at the optical tracking equipment have had the smoke of the B-26 in their "sights" for several minutes. Now, on separation, they follow the Q-2, as does the control equipment which both tracks the target and sends the remote control command signals to the drone.

The conversation between McDaniel and Williams begins almost as soon as the target is launched and "on its own."

"What do you see, chase pilot?"

Williams opens his mike. *"The drop is very nice: it is holding straight and level. Altitude is 14,500; speed 280 indicated and picking up.*

"Roger. "We're going to pick up a bit more speed and then command a turn. We'll advise you, but right now we'll hold the target straight and level."

In a few minutes McDaniel is back on VHF. "Chase plane! Stand by for a left turn."

"Wait a minute! Let me get on the other side; and be sure you make that turn. LEFT. . . . Okey. Your turn is starting . . . the bird has rolled into it. Air speed is 345, but you're losing a bit of altitude."

"Roger. Is it climbing now?

"Roger. Climbing now. Stand by and I will get you a rate of climb."

W. R. White, autopilot technician, right, instructs T/Sgt. W. C. Neal, trainee.

D. Hounsell, chief electrician, checks control box with A/1C 1. F. MacDougal.

"Keep us advised, please, on rate of climb and airspeed."

As the Q-2 piles up the minutes and adds to its test hours in the air, the conversation goes back and forth between remote control station and chase pilot. An electronic wire tape records all the information which comes over VHF for later analysis.

"Stand by for an increased speed followed by climb. Airspeed now, please?"

"Airspeed now is (deleted); altitude approaching (deleted). You are leveling out."

"Roger. We want to hold this altitude for a few minutes. After that stand by for a right turn."

"Roger. Standing by. . . . You've rolled it into the turn . . . holding fine at 3 degrees per second. Angle of bank about 45 degrees; airspeed is (deleted); altitude (deleted)."

"Roger. We are going to hold this turn for about another 200 degrees. Please follow it. Your commentary has been very good. Is the photographer getting any pictures?"

"Roger. He is doing all right."

"Please attempt to keep the target in sight. This is a very critical period."

"Roger. Will do."

"All right. Stand by, and we will level off here. We will keep the airspeed down for the remainder of the mission and hold this altitude. Please notify us of any deviation."

As the target reaches the point where the fuel is nearly expended, McDaniel asks Williams to stand by for the parachute recovery. Then comes the word: *"The chute popped out okey."*

"Roger. How is the recovery?"

"Looks pretty good. Everything in order. Settling very softly."

"Roger. Will you attempt to obtain some photographs on the way down please, and let us know probable impact point?"

Thus ends another flight in the continuing series of tests which contribute to the constant improvement of another of Uncle Sam's pilotless aircraft.

This is not the end of the story, however, because this particular Q-2 target —and many other Q-2s undergoing various tests at Holloman—must be readied for the next "hop."

Eight Ryan technicians and about 20 Air Force airmen comprise the crew which keeps the Q-2s flying. Headquarters is the 110-by-135 foot shop at Holloman. McDaniel, assigned there since the start of the Q-2 project and before that at Alamogordo on the Ryan "Firebird" air-to-air guided missile test program, heads up the Ryan group. Capt. Richards, as liaison between the contractor and the government, heads up the Air Force group.

Basically, Ryan provides technical assistance up to the point of certifying that the drones are checked out and "ready for flight" following the various operations conducted by the GIs. In practice, however, the civilian and military groups work pretty much as a single unit.

Each Wednesday, McDaniel or Richards represent the Q-2 project at a scheduling meeting attended by Air Force personnel and all the contractors at Holloman. Here the week's flight test schedule is worked out for the entire base so that necessary radar, radio, telemetering and other facilities can be properly allocated.

Telemetering device is handled by A/1C Joseph Zinn, trainee, and Herbert Shear.

Once the dates for the Q-2 flights are set, everyone bears down to have the drones ready to meet the test schedule. The jet engines, nacelle packages and airframes are the responsibility of shop foreman Clyde Hammett. It is he, and his technical sergeant counterpart in the Air Force, who must see that the targets are properly assembled and ready for flight.

P. W. Williams, control beacon engineer, operates equipment with A/1C Don Weeks.

The auto-pilots, which sense changes in the drone's flight attitude, and take the necessary measures to maintain straight and level flight, are the responsibility of William Berry and William White. Douglas Hounsell heads up the electrical system group.

Command control, supervised by Paul Williams, is the system which serves as the link between the remote control station and the Q-2. Installed in the drone, the command control system receives "instructions" and channels the signals to the proper control surfaces.

The "electronic test pilot" aboard the Q-2 is the telemetering equipment which senses all actions of the target, converts them into electronic impulses and transmits them to ground stations for recording and interpretation. Not a part of production Q-2s, but needed for the test program, the important telemetering equipment and installations are in Herbert Shear's sphere.

And, as to the ever-present paper work necessary to "keep 'em flying," that realm is presided over by Charles B. Burkholder, engineering clerk.

Before each flight, every bit of engine, airframe and electronic equipment must be carefully checked and the engine run-up on the pad. Then four other complete checks are made, first in the hangar, then when the target has been loaded into the bomb bay, next after the launch plane with its "captive" drone is in the air, and finally the remote control check just prior to the drop-away.

Actually assembly of the targets at Holloman, upon their receipt from the Ryan factory at San Diego, is simplicity itself. Less than half the size of a jet fighter plane, the Q-2 and its components are easily handled and require a minimum of handling equipment. The fuselage is supported in a target-handling dolly; then the wing section is removed from its packing crate and attached as a single unit by four bolts.

The jet engine is easily installed in its nacelle and the complete power package is then placed on a dolly and rolled into position for attachment to the fuselage. This and other operations require only two or three men. The empennage, fabricated as a single unit, is put into position without handling equipment and quickly fitted and bolted into place; then the cone containing the recovery parachute is attached. Upon completion of the assembly operations, weight and balance calculations are made, and the electronic equipment run and checked.

UNDER ARREST

(Continued from page 4)

first before the parachute's canopy can deploy and inflate.

The tremendous pull by the drag chute exceeds the rated tension which can be withstood by a frangible cord extending from the main parachute container to the lines at the vent of the main chute.

After the cord breaks, the drag chute then lowers the container and deployment bag of the main chute, while the big job of lowering the drone is taken over entirely by the main chute which keeps the target plane level during the descent.

On impact with the ground, a swivel, serving as the link between the parachute suspension lines and the strong nylon webbing "riser" attached to the drone, is automatically disconnected.

Thus the chute is separated from the Q-2 immediately on contact with the ground. This is necessary to prevent damage to the target plane by strong ground winds "picking up" the chute and causing it to drag the drone.

Many improvisations and changes in parts were required before the system was perfected. For many months, the Ryan-Air Force tests were made with a simulated target which duplicated the Q-2 in general structure and weight. It consisted of a pipe-like configuration. This provided a low cost means of testing the parachute recovery system without damaging the more expensive Q-2 targets.

After many launchings of this imitation Q-2 from "mother" launch planes, Ryan engineers announced that the reliability of the aerial recovery system was fully established.

Technical details of the exhaustive testing program were supervised by Bruce Smith, Ryan Director of Engineering, and Forrest Warren, Q-2 project engineer. W. S. Cockrell conducted the actual tests with a staff of six men at Holloman Air Development Center, which was one of two Air Force Research and Development Command Centers participating in the program.

Wright Air Development Center (Dayton, Ohio) personnel assisted Ryan engineers by providing design data, construction features and corrective ideas. Other Air Force participation included the providing of launching planes and crews, facilities of the special parachute section for repeated packing of "chutes" and the ground services required for recovery of test vehicles after drops.

And at Wright Field, parachute specialists from past experience had the solution to a particularly annoying problem, that of parachute "burns," resulting in ruptures of the nylon during the swift deployment of the "chutes." This was overcome by placing a newspaper in such a position as to serve as an anti-friction device between the main parachute canopy and the canvas deployment bag.

Information obtained by the Air Force in these tests has been used to advantage in other recovery problems.

Conditions of the later tests were so extreme they could not possibly be duplicated in actual use. When the test vehicle, in its free fall, attained a speed of approximately 600 miles an hour, the drag chute was released. A few seconds later, the main chute billowed out, and the imitation drone dropped to the ground undamaged.

Typical of the problems that arose during the long testing program was the premature operation of the swivel disconnect mechanism while the test vehicle was still in the air, during Test No. 3. Both parachute deployments were satisfactory, but a few seconds after the main chute opened, the automatic switch went into action, causing the main chute to become detached from the test bomb, which fell free to the ground and was severely damaged.

By recovering maximum weights at maximum speeds, Ryan technicians simulated the most severe conditions—conditions not attainable in actual service, because the instant a Q-2 is launched in a target flight, it begins consuming fuel and losing weight. In the most extreme experiments the test vehicle was ballasted to a simulated Q-2 flight with full fuel tanks.

Data on airspeeds at deployment of the chutes, rates of descent and magnitude of oscillation were obtained by photo theodolite coverage at four stations, use of radar and plotting board, and a photo chase plane.

A sequence timer assembly releases the parachutes through a series of actions. The timer assembly can be actuated by the "beeper pilot" who operates the remote control box on the ground, governing the target's flight.

A separate relay can be actuated from the remote control box to release the parachutes.

The conventional parachute is made flat, so that when it opens out, the mouth of the chute is nearly equal to its diameter. The parachutes used on the Q-2 are among the few "formed" types proved successful for such use. The panels from skirt to vent are formed in the exact shape they take when opened. This has resulted in considerable weight-saving, a vital necessity, since the exact-forming process requires use of less fabric.

The cloth itself is light weight with triple tear strength. Because the mouth of the parachute is narrower than the outside diameter, the canopy has a lower opening shock load, reducing the possibility of damage to the chute.

The standard guide surface or "drag" chute, also formed, has a larger diameter than the mouth opening. The canvas used in this chute also has an extremely high tear strength.

Testing of the Prevost Smith manufactured chutes in the Q-2 experiments has established their suitability to this type of application.

The Q-2 chutes must be of such a durable nature as to permit repeated use under the most critical conditions. They have demonstrated their rugged characteristics by successfully dropping very heavy objects at high speeds from high altitudes.

Since the many tests with the imitation drones, numerous successful recoveries have been made of the Q-2s, with virtually no damage to the delicate internal equipment.

The Q-2 flight test program is continuing at Holloman Aid Development Center. The parachute recovery system has been accepted by the Air Force as suitable for the Q-2 pilotless planes and has been standardized.

STMs Still Flying

Four of the 12 Ryan STM-150 training planes delivered to the Guatemala Air Force in the late 1930s are still going strong according to word just received from G. Gonzalez Gomez, a former home study student of the old Ryan Aeronautical Institute.

Ganzalez Gomez, now an aeronautical engineer on the staff of the University of San Carlos in Guatemala City, writes:

"Instructors and cadets are very fond of the planes and comment favorably on their maneuverability and characteristics. Only this morning, I saw three Ryans flying formation over the city; they were as shiny and trim as new."

DOUBLE WASP

(Continued from page 9)

of 2,500 horsepower, with additional power provided by water injection, now considered routine on takeoffs by many airliners.

The official horsepower ratings often do not reflect the tremendous power that can be generated by the R-2800. Under extreme conditions in World War II, fighter pilots got as much as 3,400 horsepower in emergencies.

While other engine manufacturers sought, during the 1920's and again after World War II, to cash in on a "flivver" plane boom that never materialized, Pratt & Whitney, under the leadership of its founder, Frederick B. Rentschler, always had its eye on the bigger planes—the large transports, the mighty military aircraft—whose high speeds and great range would necessitate high-powered, reliable engines.

Thus, in 1925, when Rentschler founded the engine manufacturing concern in Hartford, Connecticut, he was thinking in terms of large, air-cooled radial engines At the time, two of the most successful engines in America were the liquid-cooled types in the 400-500 h.p. range, being built by Curtiss and Packard.

Rentschler had just resigned as president of Wright Aeronautical Corp, where he became convinced that the radial air-cooled engine was the engine of destiny. He felt that such an engine, in the same horsepower range as the liquid-cooled engine, would be lighter in weight and improved in performance.

THE first Wasp, designed in a garage, weighed only 650 pounds and produced an unexpectedly high 425 h.p. This engine, for which the Navy — Pratt & Whitney Aircraft's first customer—paid $15,385.92, was eminently successful in its test-stand run of 50 hours that began March 4, 1926. There was an aura of the historic about this power plant, and it was retired to a place of honor in the Franklin Institute at Philadelphia and later at the Boston Museum of Science without ever having been installed in a plane.

Other Wasps meanwhile were being completed, and the first Wasp to fly took to the air May 5, 1926. By the end of that year, this engine demonstrated speed, rate of climb, performance at altitude and reliability that not only amazed everyone but actually revolutionized American aviation. For the next seven years, it shattered one world record after another, helping lift this country's air prestige to number one eminence in the world. With its sister engine, the Hornet, the Wasp demonstrated such characteristics of speed, endurance, load-carrying and high altitude flying that the Army Air Corps was able to implement its strategy of long-range bombing and the Navy its technique of the fast carrier task force—among the major factors in our air supremacy in World War II.

In 1937, an experimental model of an 18-cylinder two-row engine of 2600 cubic inches of displacement had been almost finished by Pratt & Whitney, and this was redesigned into what became the justly famous R-2800 Double Wasp, an engine that often showed it could produce far more than the 1800 h.p. at which it was initially rated.

When fighter pilots in World War II were able to extract 2800 to 3400 h.p. from the Double Wasp, the Utopia of aircraft engine designers—a horsepower for each pound of weight and each cubic inch of displacement—had been achieved by Pratt & Whitney Aircraft.

After World War II, engine manufacturers were confronted by a tremendous quantity of surplus power plants available to commercial airlines at a fraction of their original cost. But Pratt & Whitney Aircraft knew that the airline with the superior power plants will have the most profitable operations.

The company's policy of constant improvement of an engine with a basically sound design — namely, the R-2800 — again paid off. Immediately after the war's end, Pratt & Whitney had available new models, with higher performance characteristics than any of its predecessors. These were able to compete successfully with the cheaper, but out-of-date, engines, including many of its own earlier models, which were deluging the market.

Today, production of the R-2800 Double Wasp, with its 11,400 parts, is going on at Pratt & Whitney Aircraft's main assembly plant at East Hartford, Conn., and parts are made at its branch plants at North Haven and at Southington, Conn. It is still helping a lot of airlines make money. More commercial airline passengers ride in R-2800-powered planes than in any other type.

Ryan is privileged to continue playing a major role in the supply of exhaust systems for planes using the R-2800. At present, a large proportion of the San Diego plant's exhaust systems manufacturing facilities are devoted to such production for the DC-6A, DC-6B, the C-118 and the R6D; and the Convair Liner 340. In addition, spare exhaust system parts are being turned out for the DC-6 and the Convair Liner 240, as well as the Martin 202 and 404.

In the military field, spares are being produced for the R-2800 powered C-82, the original Fairchild Packet for which many exhausts were built by Ryan in the past. Production parts are being made for the Convair T-29 navigational trainer, and in a new project, the production run recently was started on the exhaust systems for the new Beech and Canadair T-36 trainer, which will be powered by the R-2800.

After almost 16 years, the Pratt & Whitney R-2800 appears to be achieving a healthy maturity. And paralleling its development has been the constant improvement of Ryan exhaust systems to cope with the stresses of hotter, more powerful engines.

RAM JETS

(Continued from page 13)

ward. The front end must be "educated" to gulp in the correct amount of air and deliver it to the combustion chamber.

The aft end must withstand high temperatures and stresses developed there. Accurate fuel-measuring devices must feed the proper quantities of fuel into the swift flow of compressed air. Baffles are required to direct the fuel-air mixture properly into the combustion chamber, and an ignition system is needed to light the fire. The "stovepipe" is far from a simple tube.

Aeronautical engineers believe that some day the ramjet may be used, not only for guided missiles, but also as a power plant for piloted aircraft at extremely high speeds, probably attached to the fuselage or wings of the plane. Also being studied by Pratt & Whitney researchers is the adaptation of the ramjet to the helicopter, with the engines attached to the whirling tips of the rotor blades. This application, of course, would require the development of a low speed, subsonic ramjet, further expanding the possibilities of this new feature of jet power.

SPACE CONTROL

(Continued from page 11)

engineers must be flexible in their conception of plant layout and must provide parts handling methods which are streamlined to meet each type of fabrication. These handling methods are, in order of increasing efficiency:

(1) Stock boxes and pallets
(2) Mobile dollies and special racks
(3) Conveyors on floor tracks
(4) Roller conveyors and monorails
(5) Powered conveyor systems
(6) Special loading devices

The first five methods enumerated are employed to convey parts between production stations. The last category covers innovations used to load and unload parts into and from machines.

In reaching for the maximum dollar

(Continued on page 28)

BOEING OFFICIALS VISIT

Work on "45" section of KC-97 aft fuselage is checked by key Boeing officials, Joe. E. Miles, second from left kneeling; Frank L. Dobbins, second from left, standing; and Robert L. Regan, second from right, standing. Ryanites in photo are Jack Zippwald (kneeling), superintendent of customer service; H. W. "Andy" Anderson, foreman, left, standing; L. M. Limbach, works manager, center; and Joerg Litell, airplane production superintendent, right.

SPACE CONTROL

(Continued from page 27)

return per square foot of floor space, Methods Engineering consider three basic questions relative to each project: (1) *Rate of production*—how fast must the parts be made, (2) *Production potential*—what is the life expectancy of the program and (3) *Type of product*—what are the size, precision requirements or special features of the product.

With these data, the department accomplishes three things: (1) Makes a flow chart to determine the manufacturing sequence required, (2) Determines the type of facilities needed and (3) Determines the number of facilities and the layout. A final recommendation, accompanied by cost estimates, is submitted to top management for approval. Usually, one or two alternate proposals are also submitted.

Clark describes the work thus, "We are always trying to make cubic feet out of square feet. Floor space is tight but we have plenty of overhead space because our buildings have clearances running from 18 to 30 feet. So, we begin by confining a layout to the minimum floor space and then try to go up. However, it costs more to go up than to spread out and we constantly have to balance this extra cost against the premium on floor space."

The key to the development of efficient parts handling systems is volume. The fascinating possibilities gleaned from conveyorized lines and automation can be realized only if parts volume is sufficient to justify the higher costs of these methods. In each segment of Ryan production, the parts handling system is tuned to the economic factors governing the project and, consequently, the techniques are quite varied.

For example, Ryan builds thousands of exhaust systems for the Continental engines of General Patton tanks along a straight-flow production line which is fed with a 140-foot powered conveyor belt. Because of the high parts volume, it is possible to use this method of parts handling and save forty percent of the space otherwise required, through the elimination of room for parts dollies. All of the production machines can be spaced close together along the flanks of the belt line.

This technique has also doubled production, with slightly more facilities, because the conveyor provides a ready bank of parts in a uniform, accessible flow. Personnel fatigue is lessened since employees are relieved from carrying parts and can devote their efforts to the production tasks. Another positive benefit is the balanced control of manufacture which a straight line permits. Every part must move to the next station or the fact becomes clearly evident. None can be lost in back-tracking or shunted to one side in confusion.

To adapt a straight-flow production layout to a project requires not only high volume but also extra machine facilities. Since the parts are not permitted to backtrack in their travel, added equipment must be stationed along the line to perform every operation. Inevitably, some of these machines will have to be operated at low load factors, depending upon their function, line speed and so on.

In the case of smaller, less expensive equipment, this sacrifice can well be made in the interest of the stepped up over-all efficiency which the straight line system provides. But, in the case of large, expensive machines, careful scrutiny of the relative gains and losses must be made before a decision is made.

To illustrate, Ryan groups the heavy presses, cecostamps and other expensive forming machines and runs "batches" of identical parts through them for various production lines. In this way, these expensive machines are utilized full time at good economy. If these machines were located in the production lines, many more of them would be required and they would have to operate at uneconomic rates to match the cadence of other machines in the lines.

Some Ryan products, such as the inner combustion chambers for General Electric jet engines, are made under both "batch" and production line systems. The tough, Inconel cylinders are blanked, coined and louvered in the forming department where batch lots are sandwiched between other Ryan components. Then, they are fed to a production line which is served by roller conveyors and aligned, spot welded, seam welded, inspected and boxed for shipment from the end of the conveyor line. The conveyor saves space, reduces employee fatigue and maintains the units in proper sequence between stations.

ANOTHER type of roller conveyor system is employed to handle Ryan's big fuel tanks, designed for Boeing B-47 Stratojet aircraft. In this instance, the handling method is dictated largely by the requirements of processing. The mammoth containers must be spray-painted, air-dried, sanded and inspected as well as transferred from one area to another. Therefore, an overhead monorail system was selected to move the cells through the closed, pressure-ventilated spray booth and the drying and sanding areas. This method makes all surfaces of the big tanks accessible for processing and provides a satisfactory way to move them down the line with little effort. Also, since the tanks are bulky and require extended time for drying, this innovation serves a dual purpose as a temporary storage facility with handling kept to the minimum.

To meet the stepped up demands of

the Pratt and Whitney Aircraft exhaust systems project, required a somewhat different approach. Each exhaust system for the Wasp Major engine is composed of seven big, stainless steel sections which are slightly different in design but similar in appearance. They are too big to be picked up and handled easily or placed upon a belt conveyor. A basic problem was the difficulty in differentiating between the similar sections and maintaining a balance of production so that complete engine sets would come off the production lines for shipment.

BY use of a tailored layout, Ryan has increased the volume of this work, improved employee morale, enhanced parts quality and save fifty percent of the space otherwise required. The layout was broken into four contiguous areas and each was circled with floor tracks and served with mobile parts dollies. Special racks were located at strategic points and both racks and dollies were keyed to the various production machines. The racks automatically count the parts produced and give visual evidence of out-of-balance conditions. Space is saved by bringing all machines together within the areas and using the dollies to convey parts. Added space is conserved by suspending the spot welding machines overhead and placing the heavy alignment fixtures on wheels and tracks also. These converge into central turntables so that they can be rotated under the spot welders to make all parts of the fixtures available.

Employee morale is stimulated because the well-defined flow lines of the system prevent similar parts from being misrouted. Workmanship is enhanced because any error shows up at the subsequent station when the part is checked. A unique method of using roving crews, who perform one task at each of the seven fixtures in a production area, has increased employee skill by contributing to greater specialization of labor.

Tracks and mobile fixtures have been used to excellent advantage in the fabrication of the Ryan external fuel tanks. It takes four men to lift the sections of these tanks and more than 30,000 spot welds are used to join them together. The handling system is designed to save manpower and space in bringing the containers to the big spot welding machines and positioning them during the welding process.

From the center of the factory, individual sets of tracks were laid to each of the eight spot welders. By means of overhead electric hoists, the heavy tank sections are loaded on special wheeled fixtures which travel on the tracks. Designed to bring the tank seams into the electrode "jaws" at the correct height, these fixtures are rolled to the machines. The tanks are free to rotate on rollers as welding takes place. At the rear end of the fixtures, a Ryan-devised hydraulic cylinder actuates the tank alignment. By means of a hand lever, the machine operator can control tank alignment so that straight seam welds may be made over tapered tank sections.

The layout has saved both direct and indirect manpower. One man can perform all loading, conveying, positioning and unloading operations instead of the four-man, two-man teams which would have to be on hand.

Among the space and time saving devices at Ryan, the mechanisms used for loading and unloading machines rate high in effectiveness. This is especially true in the jet engine building where large aft frames and afterburners must be loaded into machines and furnaces.

RYAN has installed a system of swinging cranes equipped with air-operated hoists at every strategic location. These devices are surprisingly compact, consisting of a vertical tubular steel column, bolted to the floor, and a swinging steel "I"-beam arm. Free to roll back and forth on this arm is a tiny air-motor chain hoist. These cranes are capable of handling up to 2000 pound components and are quite responsive to delicate control. Often, one hoist is located to serve more than one machine. With them, one man can load a furnace car or big lathe with little effort and without tieing up other employees to help.

Ryan uses a number of ingenious loading devices which have been made to order by the Plant Engineering department, under D. H. Palmer. To load heavy trays of jet engine parts into Knapp annealing furnaces, Ryan engineers designed steel, grid-type conveyors which are hydraulically moved into the furnace. Raised rails carry the trays back and forth. The system also shunts the trays to either side of the loading area so that the furnace can be unloaded and reloaded with a single opening of the door.

These mechanisms save manpower but, most important, they allow the furnace operators to stay on the job by removing them from the hot blast of the open furnace. With push-button controls, the operators can work at a safe, comfortable distance. Heat lost through open furnace doors is kept to a minimum by the fast action of the loading devices. If a quick quench following heating is prescribed, the loader is a positive means for meeting the requirements.

Ryan performs a ticklish quick quench job with another type of conveyor which was also designed and built by Plant Engineering. With certain aluminum alloys, it is necessary to heat the metal to 925°F. in a molten salt bath, then quench it in cold water. This strengthens and hardens the metal. To obtain maximum strength, the hot metal must be quenched within 10 seconds after removal from the molten salt bath.

Ryan designed a large conveyor, operated by a variable-speed motor, with brakes, and a chain drive. Damping devices are used to prevent the conveyor basket from swaying as it moves. In operation, the conveyor slowly removes the parts from the hot bath, speeds them along a horizontal path to the water quench tank and gently lowers them into the cold water. This is accomplished in less than ten seconds. Care in removal and insertion of the parts is mandatory to prevent warping of the hot metal.

TO transfer parts throughout the factory in the simplest fashion, Ryan designed and built a variety of custom tailored racks. These carriers are made of welded steel frames with padded separators which are tailored to fit each type of part. They are equipped with large wheels for easy movement.

By designing the racks for the parts, it was found that a great many more components could be accommodated than with the standard "tote" boxes. For instance, 204 jet engine struts can be carried in one mobile rack which takes little more space than the old type boxes that carried only forty. Another typical rack neatly contains thirty combustion chambers in contrast to the nine which could be placed in an ordinary box.

These racks make better use of factory floor space by their capacities for storing parts. The parts are kept in better condition because they are separated and not shuffled together. Personnel like the racks because they are easier to push, load and unload.

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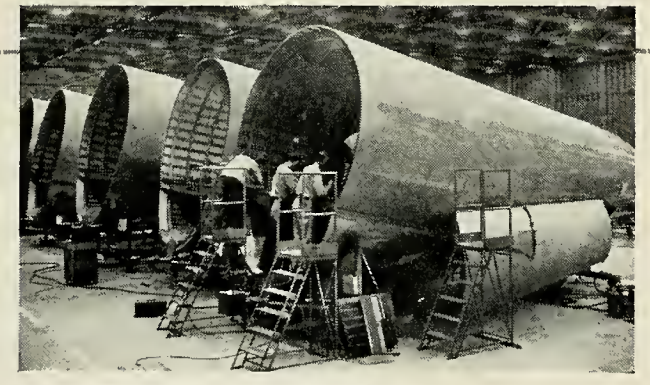
57 80

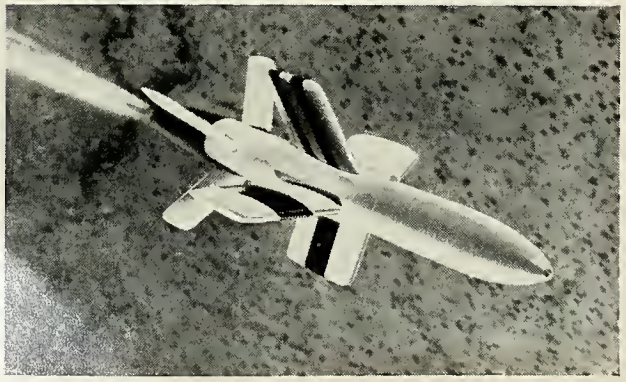
RYAN

AIRCRAFT AND AERONAUTICAL PRODUCTS



FUSELAGES FOR BOEING C-97

RYAN'S AIR-TO-AIR "FIREBIRD" MISSILE



Thirty years experience in the aviation industry has well prepared Ryan for its present activities—activities that carry into virtually every field of aircraft development and production. From the manufacture of airframe components, huge fuel tanks and executive-liaison airplanes...to electronic research and development...to high-speed pilotless aircraft and jet propulsion research, Ryan activities blanket the aircraft field.

VOLUME PRODUCTION OF AFT FUSELAGE SECTIONS for Boeing's C-97 Stratofreighter is typical of the components manufacturing work carried on for many years by Ryan's Airplane Division. For the C-97, Ryan also turns out refueling pods, cargo doors and floor beams.

THE FIRST RESEARCH MISSILE OF ITS TYPE to be revealed by the Air Force was Ryan's "Firebird" air-to-air guided missile. It has led Ryan into new developments in pilotless aircraft and electronics research. The XQ-2, now flying, is Ryan's new pilotless jet target plane with fighter plane performance.

Ryan SINCE 1922

AIRPLANE DIVISION

RYAN AERONAUTICAL COMPANY

LINDBERGH FIELD • SAN DIEGO, CALIFORNIA

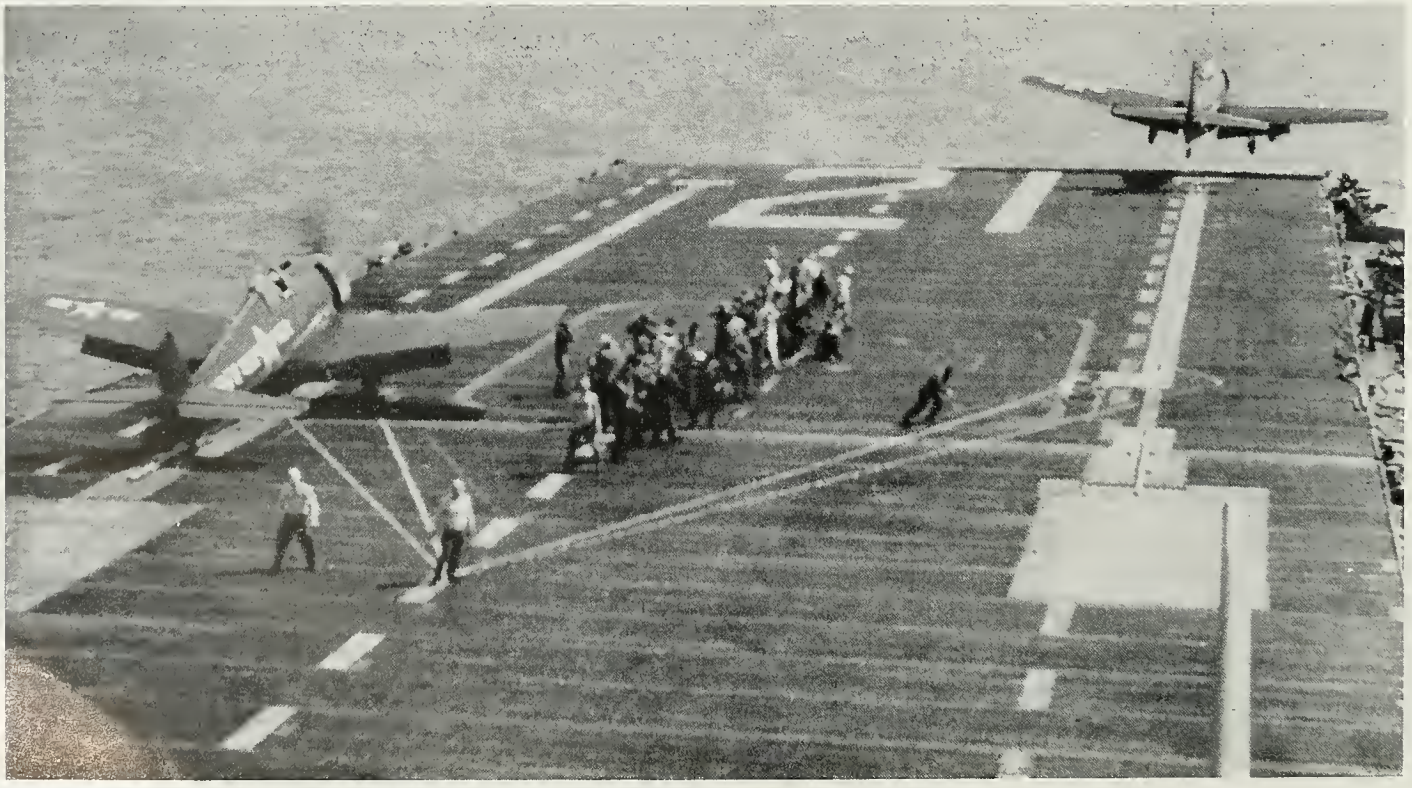
Ryan REPORTER

VOL. 14, NO. 2

Drone planes, such as this Boeing B-17 Flying Fortress shown taking off at Eniwetok Island, were used for atomic bomb test in 1946.

TACTICAL DRONES

Pilotless "suicide plane," Navy F6F Hellcat robot, with powerful warhead, goes aloft from carrier Boxer to destroy enemy target.



Small remote control box, viewed by high-ranking officers, governs flight of pilotless aircraft as large as B-17 Flying Fortress.

WHEN the Navy launched six pilotless F6F Hellcat dive bombers from the carrier Boxer off the coast of Korea last September and successfully smashed enemy targets ashore, the story was over-billed in the press as the start of "push-button" warfare. Yet it did mark another significant step in the armed forces' perfection of the use of tactical drones in warfare. Much more progress, far beyond what has been announced, has been made in the past two years.

Development of the technique of remote-controlled delivery of a lethal load by air goes back 36 years. The Air Corps was an infant still coping with the problems of keeping piloted planes in the air when it boldly ventured into the field of robot missiles—back in 1917.

The first Air Corps drone was actually a controllable robot bomb which used a conventional torpedo as the fuselage and a double wing airfoil with a 30 h.p. engine. A flight of 16 miles was made, and later, when radio remote control was introduced, a target 36 miles away was hit twice, one 60 miles away was struck three times and one 90 miles distant was hit once.

By the standards of those days, such performances could be considered sensational. "Push-button" use of guided missiles and tactical drones as effective weapons of warfare might well have been perfected by World War II if constant research had been encouraged. But the project was dropped in 1924. It was a time when men such as "Billy" Mitchell were ignored, and air strength, as well as new experiments, was allowed to sag.

In the 1930's, interest was revived in drones. The principle of "nolo" (no live operator) flight occupied the Navy's attention at the Naval Aircraft Factory in Philadelphia and the Naval Air Stations in San Diego, Cal., and Cape May, N.J. Today a full-fledged Navy air development center at Johnsville, Pa. is concerned with development of radio remote-control aircraft.

Use of the Hellcat drones in Korea is not even a new weapon for the Navy, which during World War II employed

(Continued on page 18)

Ground crew takes over remote control of single-engine drone as mother plane, two-engined Grumman F7F Tigercat, veers off after guiding robot early in flight.

N.A.C.A. RESEARCH

by

John W. Crowley Jr.

Associate Director of Research
National Advisory Committee for Aeronautics

Written especially for the Ryan Reporter

THE product of the NACA is research information. During 1952, the NACA published nearly 1,000 technical documents reporting results from research in aeronautics. Many of these reports contained classified security information, and the circulation of these was closely controlled for reasons of national security. Others, which are unclassified, are available to the public in general.

Established by Congress in 1915, the National Advisory Committee for Aeronautics is commissioned to conduct and direct the scientific study of the problems of flight. To pursue the practical solution of these problems, the NACA employs 7652 administrative and technical personnel and operates the world's most advanced aeronautical research laboratories.

These facilities must duplicate in the laboratory the conditions encountered by

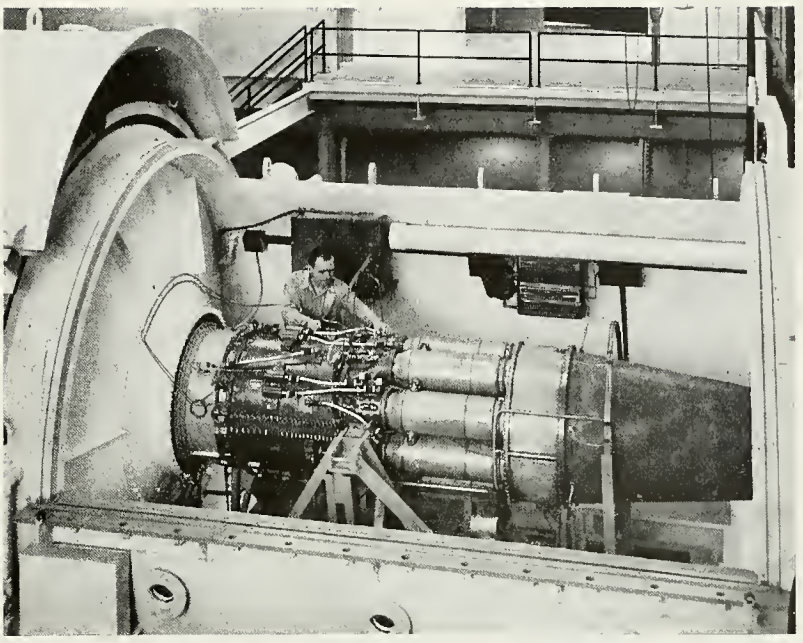
An NACA technician is mirrored in the polished stainless steel walls of the world's largest supersonic wind tunnel as a ram-jet engine is readied for 1100 m.p.h. "flight."

aircraft flying at high speeds and altitudes. Air pressure drops from 14.7 pounds per square inch to only 1.7 psi at 50,000 feet. Air temperature decreases from the NACA standard of 59.5°F, at sea level to —67°F. above 35,000 feet.

Complicating these extreme conditions are the rises in pressure and temperature which accompany the ram effect resulting from the huge quantities of air rushing into jet engines operating at high speeds. For example, the ram effect experienced by an airplane flying at 35,000 feet at twice the speed of sound (Mach 2) would result in a pressure rise from 3.5 psi to 27 psi and a temperature increase from —67°F. to 250°F.

In 1952, a new research tool was put into use at the NACA's Lewis Flight Propulsion Laboratory. What made the event of great importance was that it came at a time in the world race for air supremacy when bigger, more efficient

(Continued on page 24)



A G-E jet engine, equipped with Ryan combustion chambers, exhaust cone and aft frame undergoes a high speed and altitude run in NACA test tank.

Test pilots for airplanes that have not yet been built

NACA's massive, man-dwarfing compressor can blast 2-million cubic feet of air a minute through the supersonic wind tunel.

THE 1952 BUSINESS

The Figures . . . . . .

	TOTAL	PERCENT	Per Ryan Worker
INCOME **for 1952 from the sale of Ryan products - -**	**$34,975,214**	100.0%	**$9582**
In making these products, Ryan paid these bills:			
A. Cost of HUMAN ENERGY paid in WAGES AND SALARIES -	**$15,344,699**	43.9%	$4204
B. Cost of MATERIALS AND SERVICES bought from others - -	**15,230,319**	43.5%	4173
C. Cost of TOOLS AND FACILITIES WEARING OUT - - - - - (The accounting term is Depreciation)	**544,042**	1.6%	149
D. Cost of PAYMENTS ORDERED BY GOVERNMENT - - - - (Federal, State and Local Taxes)	**2,977,795**	8.5%	816
E. Cost of USING TOOLS OF PRODUCTION *(Profit)*			
"Take-Home Pay" of 1000 Owners (Dividends) - $196,921 (0.6%)			
Re-invested in the business - - - - - - - - 681,438 (1.9%)	**878,359**	2.5%	240
COSTS for the year totaled - - - - - - - - - -	**$34,975,214**	100.0%	**$9582**

SIMPLIFIED BALANCE SHEET

At October 31, 1952

F. Current Assets	$22,223,565	G. Current Liabilities	$17,948,658
H. Other Assets	14,700	I. Other Liabilities	148,834
J. Net Fixed Assets	1,757,737	K. Stockholders' Equity	5,898,510
	$23,996,002		$23,996,002

See Detailed Explanation Pages 20 and 21.

YEAR AT RYAN

The FACTS *Behind the Figures*

A. COST OF HUMAN ENERGY paid for in WAGES AND SALARIES . . . $15,344,699

The wages and salaries paid to Ryan employees last year took $43.87 of every hundred dollars the company received from its customers. During the fiscal year from October 31, 1951 to October 31, 1952, the average number of employees on the payroll was 3650. The annual pay of the average worker was $4204.

The wage and salary bill included the cost of sick pay, paid vacations, holiday pay and rest periods. In addition to the wages paid directly to Ryan employees, the company made other substantial payments for such items as unemployment insurance tax, workmen's compensation and social security.

Wages and salaries paid to Ryan employees buy homes and furniture, education, television sets, insurance, food and clothing — help make local business prosper. As one of the large employers in San Diego, Ryan's $15,344,699 payroll last year was, for the most part, spent here and added to the city's high level of prosperity and standard of living.

You may be wondering, too, about the pay of executives. You may have an idea that fabulous sums are paid them. Ryan employees would be surprised at the comparatively modest amount received, after taxes, by the men whose initiative and leadership have made possible the many jobs in our plant. These sums represent a minute percentage of the total amount paid in salaries, yet no one will deny the fact that the security of the average worker's job depends on the ability of executives to obtain and hold customer business and to manage and plan to keep the plant running efficiently and profitably. The healthy operation and growth of the Ryan company through many years is a measure of success with which they have fulfilled and continue to fulfill the all-important responsibility of their assignments.

B. COST OF MATERIALS AND SERVICES bought from others $15,230,319

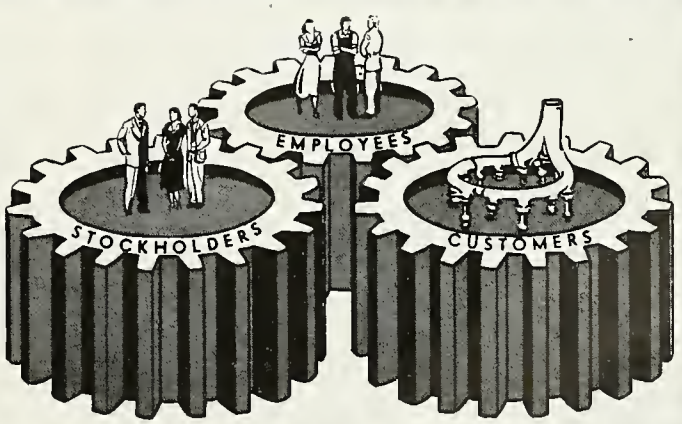
Out of every hundred dollars taken in by the company, $43.50 was needed to pay for the materials, purchased parts and sub-contracted components used in making the products we sold our customers. In the course of the past year, the company bought $4173 worth of materials and services for each and every employee to provide the supplies which keep production lines rolling.

The greater part of the $15 million spent was paid by Ryan to a broad cross-section of industry which furnishes *materials* such as steel, aluminum, rivets, welding rod, paint, castings, etc., and *services* such as heat, light, gas, printing, telephones and the many other daily needs.

The money for materials is spent in practically every state and helps to make better business and more jobs in every section of the country. Insofar as possible materials and services are bought from local firms and contribute to the welfare and prosperity of the San Diego area.

As is the case at Ryan, companies who furnish us materials and services pay an average of about 50 cents out of every dollar to their employees. Thus, if we add the payrolls represented by the materials and services we buy to the wages and salaries of our own employees, we find that approximately 67c out of every dollar Ryan takes in ends up in pay rolls.

To make the Employee, Stockholder and Customer "gears" of the American industrial machine mesh properly is the three-fold job of Management. When the machine runs smoothly, everyone benefits. Employees get good wages; investors get a fair return on the savings they have risked to buy the tools of production; and customers receive "their money's worth" in the goods produced. It takes real management skill to serve three masters equally well.



Huge stocks of stainless steel and aluminum, purchased parts and subcontracting, required expenditure of $43.50 for every $100 paid the company by its customers during the past year.

C. COST OF TOOLS WEARING OUT $544,042

This is the item accountants call Depreciation. It represents the amount estimated to be necessary to provide for replacement of the tools of production at the end of their useful life — and by tools of production we mean each and every machine and building we have.

Last year this amounted to $544,042 and in 1951 the amount was $334,792, making a two-year total of $878,834 available for the purchase of replacement tools, buildings and other production facilities. During the same two-year period $1,365,000 was invested by the company in additional and replacement equipment.

Thus it will be seen that the difference of approximately $500,000 had to come from money that was available out of previous years earnings for just such situations. It is only by the constant maintenance of modern plant facilities, and adding to them as demand from customers increases, that the company can assure its continued growth and thereby provide expanding employment.

Each year we plan to set aside a percentage of the cost of each machine or facility we have so that when a replacement is needed at some future date the money to buy it will be on hand.

But suppose we had not put aside this money? What would happen to the jobs of those whose work is directly connected with the tools which will wear out this year? How much would the working force have to be reduced if the work these tools did for us had to be bought outside from some other company? What chance would Ryan have, with obsolete machines, to compete against other companies in obtaining new business?

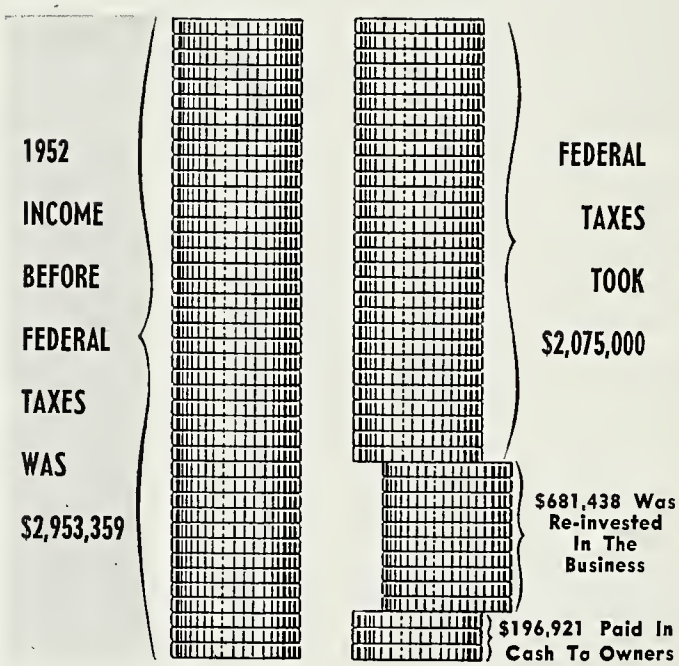
To keep up with progress, stockholders must provide more money than available from depreciation charges in order to replace worn out machines and buildings. So as to provide for this continued growth, the owners "re-invest" a large percentage of their so-called "profits" each year.

D. COST OF PAYMENTS ORDERED BY GOVERNMENT . . $2,977,795

To carry its share of expenses of Federal, State and Local governments, Ryan Aeronautical Company paid out (exclusive of withholding tax) the equivalent of $816 for every employee on the payroll last year. That's $68.00 per month per employee. A year ago our taxes amounted to $52.08 per month per employee.

Because of the regular and so-called "excess profits" tax on corporations, an extremely high proportion of earnings is required to be paid to the Government, which is a heavy burden on a growing company like this one. It is of interest to note that 1952 Federal taxes on income took 70 cents out of every dollar of profit earned. This compares with 39 cents out of every dollar in 1948, 38 cents 1949, 47 cents in 1950 and 51 cents in 1951.

"Corporation taxes" hardly describe the true nature of the tax collected from business firms. Although these taxes are paid by corporations they are passed along eventually to the customers — you and me — who are the source of corporation income. In setting the selling price of a TV set, for example, the manufacturer must estimate his tax in advance and make it a part of the retail price paid by you, the buyer.


1952 INCOME BEFORE FEDERAL TAXES WAS $2,953,359
FEDERAL TAXES TOOK $2,075,000
$681,438 Was Re-invested In The Business
$196,921 Paid In Cash To Owners

In the role of tax collector, Ryan last year relayed to Federal, State and Local governments $2,977,795, which we in turn had received from our customers.

These taxes are spent for the support and services of government — national defense, public safety, schools, hospitals, farm subsidies, "free" education and medical services, etc. But nothing which comes from the government is, in fact, "free." Taxes collected from the people are the government's only sources of revenue. You and I must foot the bill.

E. COST OF USING TOOLS OF PRODUCTION (Profit)

Take-Home Pay of Owners (Dividends)	**$196,921**
Re-invested in the Business (so-called Surplus)	**681,438**
	$878,359

Due to the many unwarranted attacks in recent years on the American business system of Free Enterprise the word "profit" has become one of the most misunderstood in present

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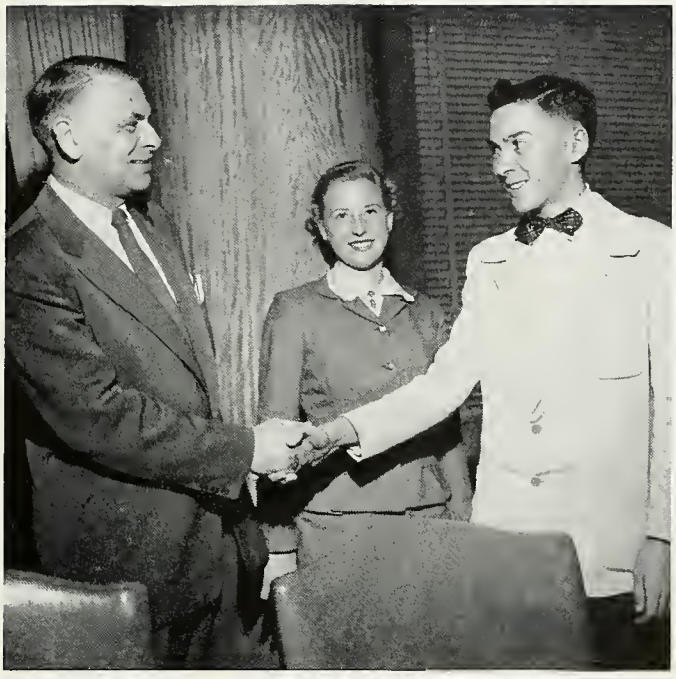

R. A. F. Ballou, West Coast regional director of Junior Achievement, congratulates Richie George, author of this article, and Marianna Summerhill, both J. A. speech contest winners.

Because the Ryan Aeronautical Company is a living example of how the American free enterprise system works — with the "boss," T. Claude Ryan, having started business with a single airplane and a piano crate for a shop — this concern enthusisatically sponsors two Junior Achievement companies. Miniature business ventures, Junior Achievement companies are run by high school students in cities all aver the country.

Practical experience in how a business is financed, the competition it must face to survive, its production and marketing problems, is obtained by boys and girls striving for a successful business venture and dividends to stockholders by the end of eoch school year. The Ryan-sponsared companies are making and selling television lamps and folding utility tables, with the technical advice and assistance of Ryan employees. Both products won the right to represent San Diego in a national Junior Achievement contest to be decided in May.

Following are views about Junior Achievement expressed by one of the students themselves. Richie George is a member of Ryan-sponsored J. A. Enterprises, and placed second in a city-wide speech contest to choose a panel of student speakers presenting the J. A. message to service clubs and other organizations.

JUNIOR ACHIEVEMENT

by Richie George of J. A. Enterprises

Ryan advisors and students display Junior Achievement televisian lamps. Seated, Patsy Codding, Alice Taylor, Sally Burkhart. Standing, A. C. Woerner, Ed Parker, Jim Kerns of Ryan.

Here in America, our free enterprise system enables the average citizen to operate his own business. This system is unequalled anywhere in the world, but, unfortunately, many of these businesses fail, due to lack of practical experience. Junior Achievement, however, offers the opportunity for this experience to thousands of American students. The effectiveness of this program can be clearly recognized when a comparison is made between the failures of adult businesses and those of Achievers.

But what is Junior Achievement? To me, Junior Achievement, or "J. A.," as it is often called by its members, teaches high school students the fundamentals of business and helps them to gain practical knowledge by working together in their own companies. The Achievers first decide on an article or service to sell, go into production, advertise, market their product, and carry on all of the activities of a large scale business.

By buying stock in their companies and also selling stock to others, the members learn the important position of the stockholder in the operation of a business.

From each firm that sponsors a J. A. company, come advisors who help the students gain the most out of this valuable program. These advisors supervise the meetings, but do not do all of the work, as one may think. Rather, they guide the students at each company meeting, passing along their knowledge in the various fields of production, sales, and management.

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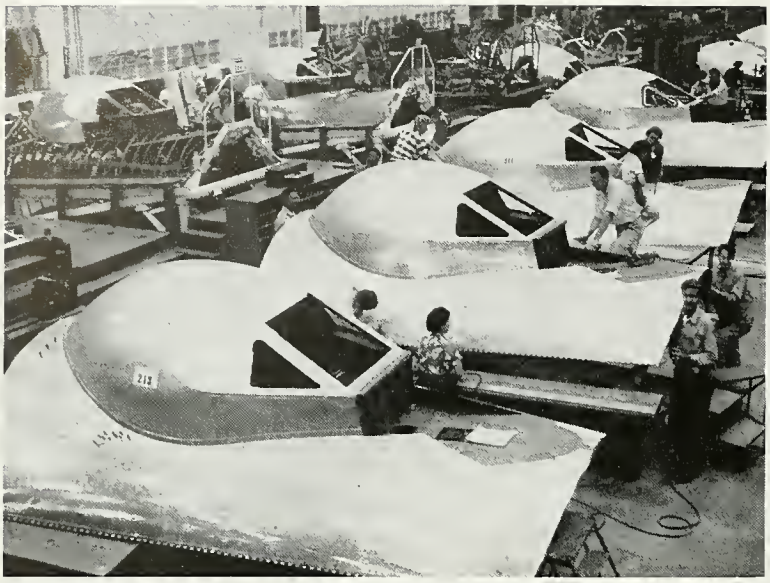
KING-S

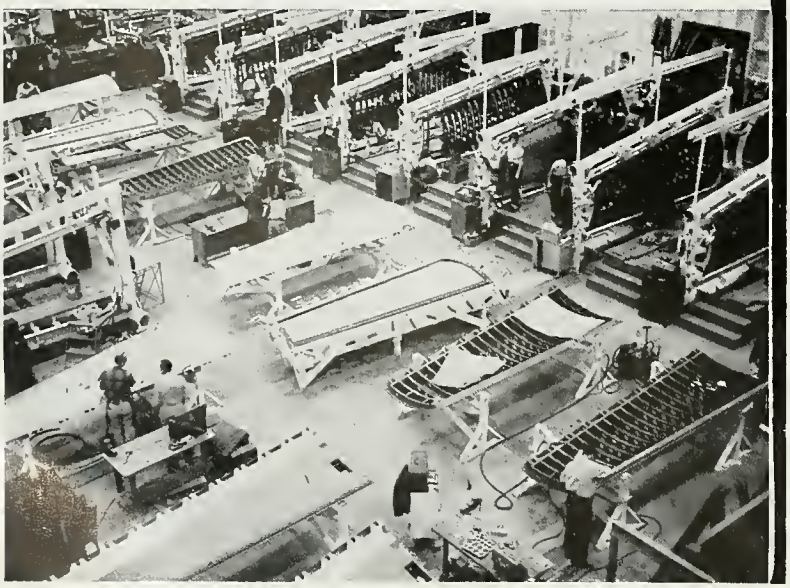


Deftly sculptured from formed aluminum skins and frames, these complex-shaped pods help convert the Stratofreighter into an aerial tanker. Inverted and slipped into the rear cargo bay, they contain operator and controls for mid-air fueling tactic.

MAMMOTH aft fuselages will be rolling from Ryan at nearly twice the previous rate by June. To keep pace with the demand for more big Boeing C-97 Stratofreighters, Ryan is sharply stepping up production of the elephantine structures by almost 100 percent. Incredibly, this build-up will consume only 13 percent more space and relatively few additional tools and equipment.

Ryan production men pull a 90 percent bigger rabbit out of a 13 percent larger hat

Bird's eye view of cargo door assembly area discloses array of fixtures needed for this component. Rubber strips around door edges form an air tight seal for pressurized flight operations.



$15,000,000 Contract for C-97 Components Received

New orders totaling approximately $15,000,000 have been received by Ryan Aeronautical Company from Boeing Airplane Company, Seattle, for accelerated output of C-97 aft fuselage sections and other components for this military transport plane.

Ryan's backlog skyrocketed as a result to a peak of $80,000,000, highest since World War II. The recent orders from Boeing called for a substantial increase in Ryan's output of the huge aft fuselage sections, refueling pods and floor beams for the combination cargo plane and flying tanker.

A substantial proportion of the San Diego factory's floor space has been devoted to C-97 production during the past four years. In April, 1952, Ryan was given orders for $25,000,000 worth of C-97 components. Two years ago, when the Air Force announced the K-97 "Flying Tanker" model incorporating Boeing's "Flying Boom" for aerial refueling, Ryan began production of the refueling pods as well as fuselage sections.

Recent rearrangement of facilities in the C-97 production departments has enabled Ryan to almost double the output of aft fuselage sections without increasing the floor space. At the same time, room was created for additional jigs and fixtures needed to meet increased production schedules.

Ryan's current backlog of $80,000,000 compares with $45,000,000 worth of orders on hand a year ago and $29,000,000 two years ago.

Employment has been rising steadily for almost three years. Ryan's payroll now is well over the 4200 mark and is expected to go up another 500 by the end of this year. Production of some airframe and engine components has been scheduled up to 30 months in advance, according to T. Claude Ryan, company president.

IZE COMPONENTS

Four years ago, Ryan began to supply these important components for Stratofreighters. Since then the versatile C-97 has continually expanded its usefulness to the Air Force. With twice the volume of a railroad boxcar and 375-mile-an-hour mobility, the capacious air freighter has performed a triple logistic function. It can rush 131 fully equipped troops into combat, pack 34 tons of cargo or carry 107 casualties to medical aid.

In 1951 another significant role was added to the Stratofreighter's missions. It was transformed into a flying "gas station" to fuel gas-hungry aircraft in mid-flight. With a Boeing-designed transfer boom the tanker versions have refueled every type of combat plane from fighter to bomber. Undoubtedly, the success of this "Flying Boom" operation has given new effectiveness to combat aircraft by extending their range and take-off facility.

To call the aft fuselage sections "components" is somewhat of an exaggeration. They are the largest structures which Ryan has built and involve many more manhours of production than many of the twenty odd full-scale airplane designs which Ryan has produced. Basically, they consist of five separate sections which are fabricated individually and assembled together to form a structure that is approximately 38 feet long and 11 feet in diameter at its larger end. The five sections are: A huge "45" section, a smaller "46" section, a "47" tail-cone section, a set of clam-shell type cargo doors and a large pod section which contains the operator and controls for in-flight refueling.

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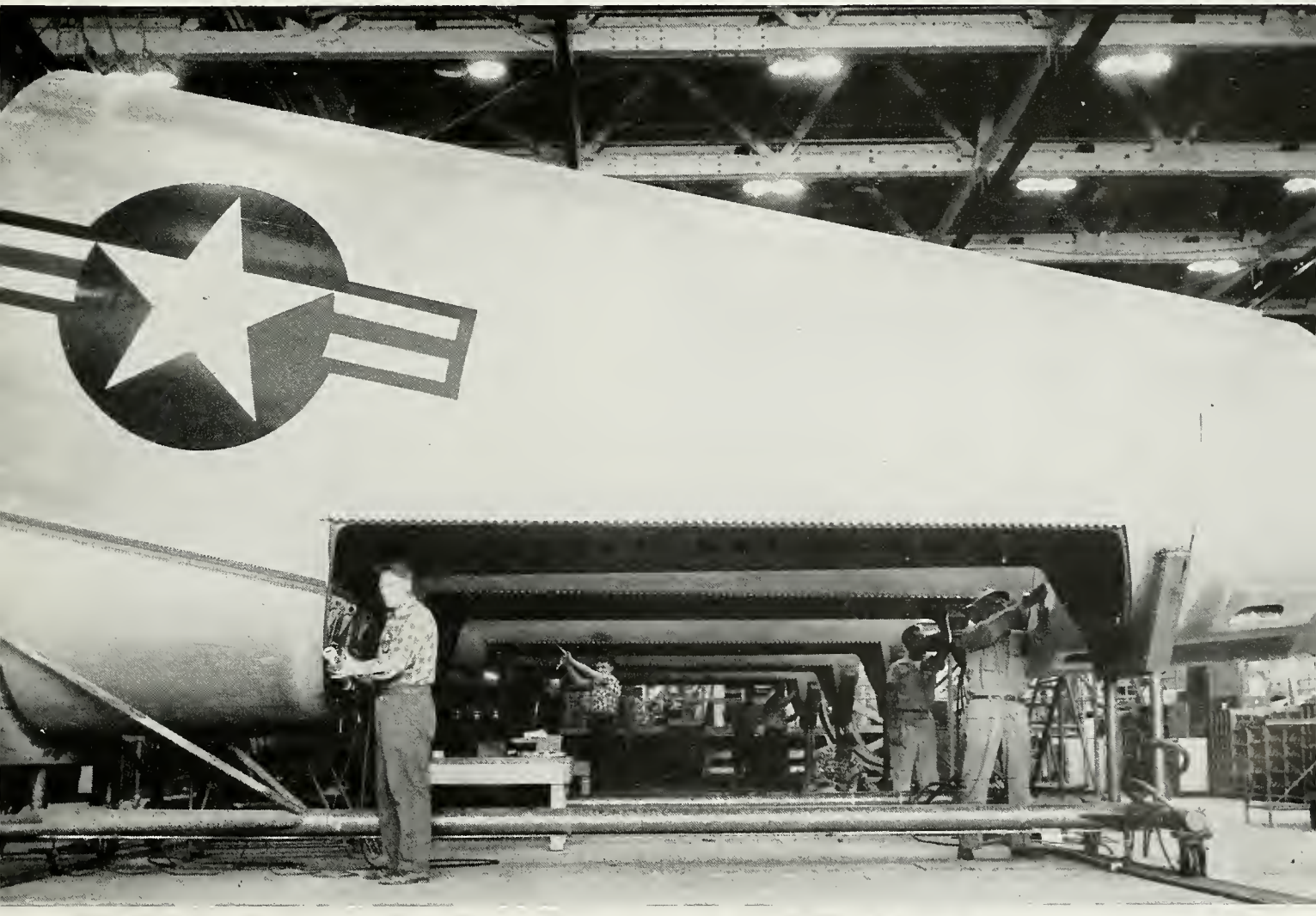


Framed in the big aft fuselage loading bays, Ryan employees prepare to install clam-shell cargo doors on the final assembly line.

This is the way John Choma and the test instruments appear to leak detectors before pressure hatch is closed and the search for air leaks is begun inside.

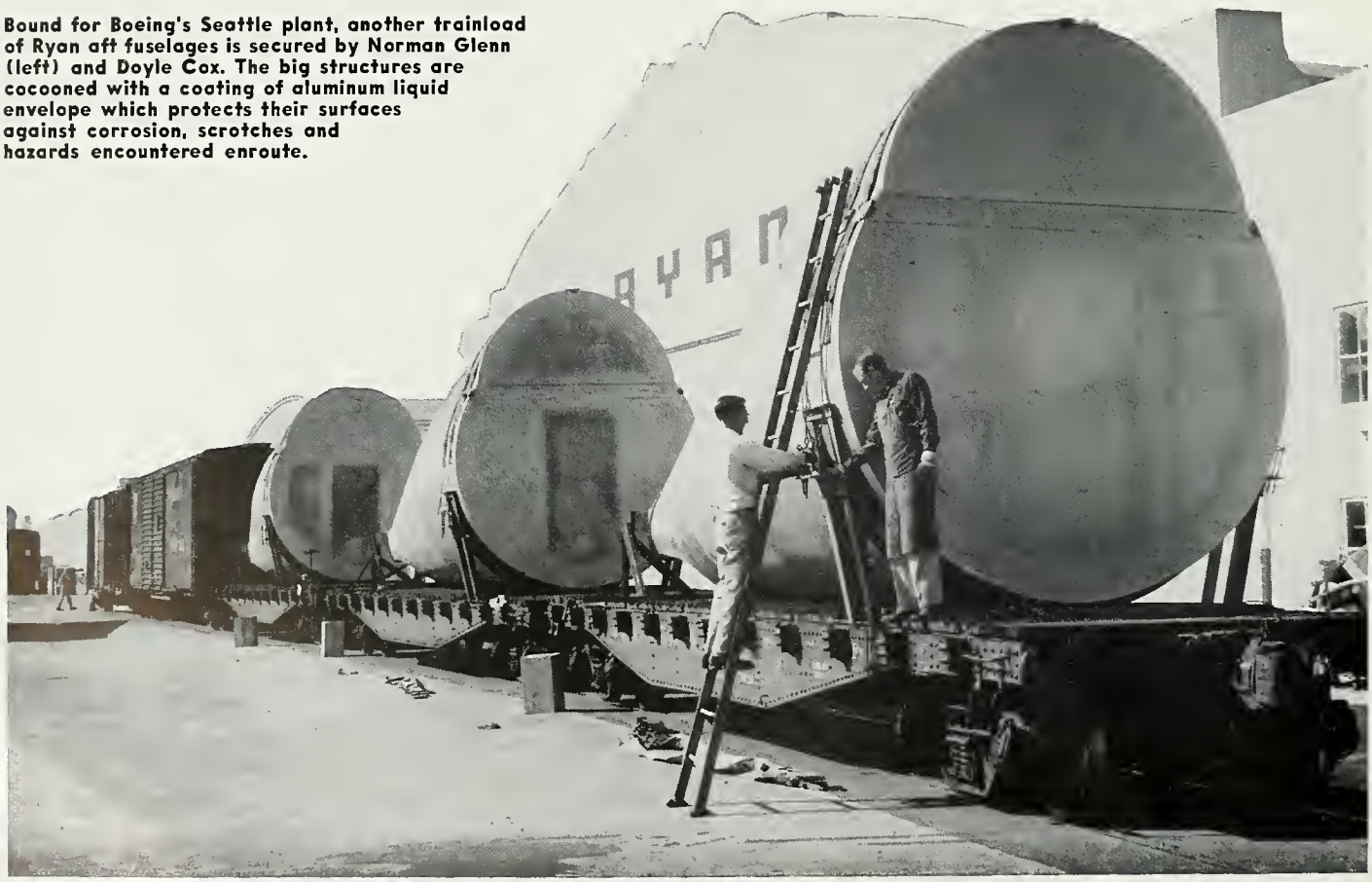
These elements are skin-stressed components which are riveted together with more than 83,000 rivets. Like her sister ship, the Boeing Stratocruiser commercial airliner, the C-97 is pressurized for high altitude service and flush-riveted for greater flying speed. These requirements demand that every exterior rivet be countersunk-fit and that all seams and joints be made as snug and leak-proof as possible.

Upon receipt of production for almost twice as many aft fuselages per month, Ryan methods engineers began to scurry for more factory floor space. At first glance it appeared that at least 35,000 square feet of additional space would have to be found to accomplish the project. A painstaking analysis of the entire program was made, based upon the fundamental objective of getting maximum production from present facilities. Out of this study a new layout has been evolved and placed in operation which requires only 10,000 added square feet — or 13 percent more space. The new layout provides improved parts flow, better assembly methods and more efficient handling fixtures.

Ryan forms practically all of the thousands of aluminum alloy ribs, stringers, longerons, brackets, bulkheads, beams and other parts which go into the aft fuselage production. The formed parts were brought to each of the five major assembly areas where they were fabricated into sub-assemblies. The sub-assemblies were built into intermediate assemblies and these units were incorporated into the final assemblies which compose the basic elements of the aft fuselages. Because of this pattern of one assembly flowing into another it was not possible to establish simple straight-line production methods.

Ryan methods engineers Harry Holyome and John Roush gained substantial improvement over the former layout by centralizing the sub-assembly work according to the type of assembly rather than keeping it grouped around its immediate destination. In each of the five assembly areas there were similar types of work performed for different components. These similar kinds of assembly operations were brought together so that a larger volume of work could be scheduled at a more uniform flow. This pulled

Bound for Boeing's Seattle plant, another trainload of Ryan aft fuselages is secured by Norman Glenn (left) and Doyle Cox. The big structures are cocooned with a coating of aluminum liquid envelope which protects their surfaces against corrosion, scratches and hazards encountered enroute.



some of the work farther away from its immediate destination but this disadvantage was far outweighed by the increased efficiencies obtained.

By grouping the sub-assembly operations together it is possible to obtain greater utilization of tools, personnel and supervision and make it easier to schedule the flow of materials. One example is the use of hopper-fed Chicago automatic riveters which are being used wherever possible because they are fast, efficient and require only one operator. Five of these machines are grouped in one compact circle. They are loaded with different sized rivets running from 1/8" to 3/16". A large variety of small parts can be riveted by these machines. If these small parts were widely separated, as before, it would rquire many more of these machines to do the work and they would operate at lower load factors.

In another instance, two radial arm drills, used to drill attaching holes in heavy bulkheads held in three large fixtures, were operated at separate locations. Two of the assembly fixtures were accessible to one drill while one fixture served the other. As a result, one drill was overworked and the other operated only two hours a day. By moving the three fixtures together each drill can now serve two fixtures. This permits a balance of the work, higher utilization of the drills and increased production of parts.

Another methods engineering technique, used to stimulate production, was the improvement of assembly methods. Inherently, aft fuselages require a number of large fixtures. Several useful ideas were exploited to get more production through these fixtures so that more of them would not be needed.

The largest fuselage frames had been built in big fixtures which permitted only two employees to work on each assembly. By building this frame in three parts, on benches, and using the fixtures for assembly only, it was possible to produce these frames at almost three times the former rate. Due to enhanced accessibility, six employees can now be devoted to this operation instead of only two. Each workman performs a more limited number of operations and consequently attains a higher efficiency.

Similarly, a saving of three hours in the assembly of the refueling pod was achieved by attaching the support bracket to the boom compartment before the unit was placed in the pod fixture. This change allowed more employees to perform the work, simultaneously, than

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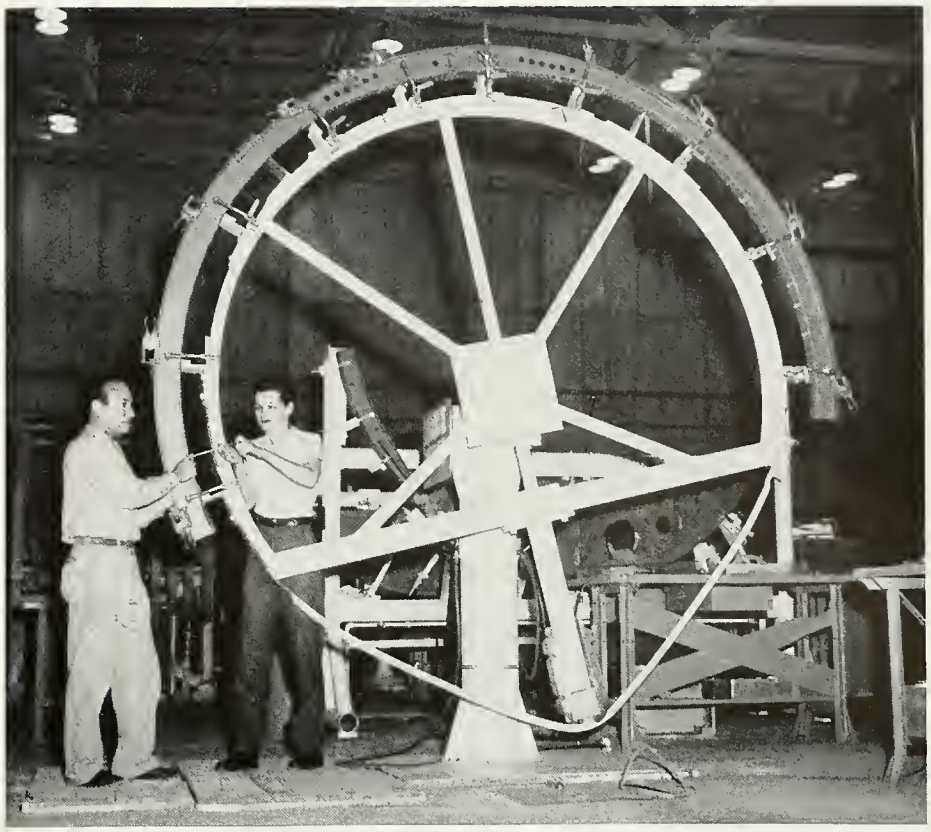
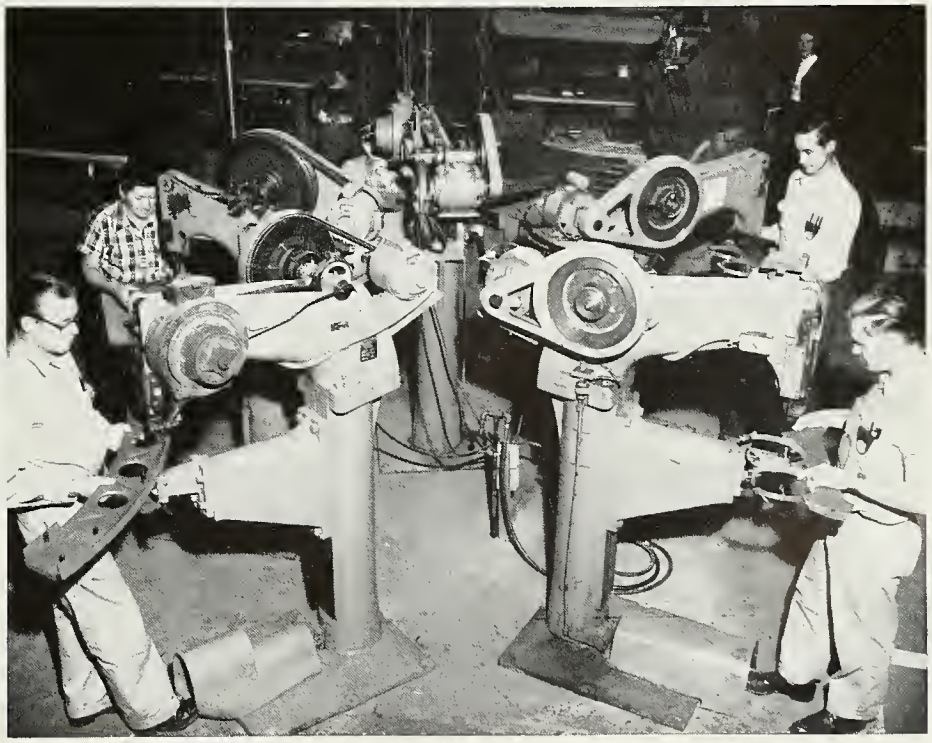


Jose Osuna and Alice Gorman show how fuselage frames, made in sections on benches, are assembled on big fixture. Formerly, they were completely built on the fixtures.

Example of better machine utilization is this group of Chicago Automatic Riveters which provide a variety of different size rivet facilities within a compact area.



1. Streaking off "on its own" over the New Mexico desert, Ryan's spectacular "Firebee" pilotless jet-propelled target drone is shown at the instant of its release from belly of B-26 "mother" aircraft.

A "BEE" with an electronic brain signalizes one major phase of Ryan Aeronautical Company's concern with the "push-button" features of future airplane development.

The spectacular Ryan "Firebee," from which the curtain of secrecy was recently lifted by the Department of Defense, is America's newest turbo-jet, pilotless target drone, capable of near-sonic speeds at high altitudes.

Somewhat less than half the size of present-day jet fighters, the "Firebee" has performance characteristics virtually duplicating those of jet planes in combat over Korea. Therein lies its immediate value to the armed forces. By remote control from the ground, it can simulate high-speed, evasive tactics of enemy planes to offer the greatest challenge to the skill of anti-aircraft gunners, training in either ground-to-air, or air-to-air marksmanship.

Remote control commands also operate to recover the "Firebee" after its target run. A specially designed parachute system, integral with the drone, lowers the target without damage to its structure or

THE BEE WITH TH

2. Responding ghost-like to controls that may be miles away, Ryan "Firebee" flashes ac

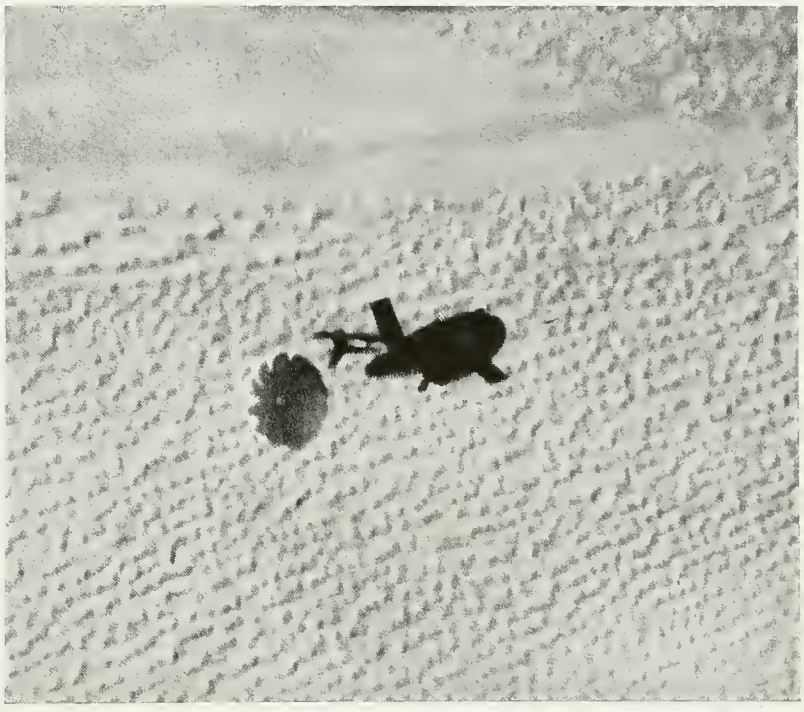
Ryan's Firebee, America's newest turbo-jet, pilotless target duplicates performance qualities of jet planes in combat over Korea

delicate electronic apparatus, so that it can be used over and over.

The power plant of this clean-lined robot aircraft with sharply swept back wings and tail surfaces is a Fairchild J-44 turbo-jet engine of about 1000 pounds thrust. The engine is six feet long and 22 inches in diameter and weighs 300 pounds. The 1800-pound airframe is approximately 18 feet long with a 12-foot span.

Scores of successful flights have been made by the "Firebee" over the New Mexico desert while it was a secret project of the Air Force, Army and Navy at Holloman Air Development Center, Alamogordo, N.M. during the past two years. Technical cognizance of its development was held by the Air Force's Air Research and Development Command and Wright Air Development Center.

Push-button heart of the "Firebee" project is a small "black box" containing a control stick and switches to govern engine speed and other flight conditions, and to transmit command signals to the drone. By use of this ground remote



3. At the end of a target flight, the "Firebee" can be recovered undamaged for further use by a parachute system which decelerates drone from near-sonic speeds, and then lowers it gently to earth.

ELECTRONIC BRAIN

he sky, ready to simulate fighter plane tactics in sharpening anti-aircraft defenses.

control station, the "nolo" (no live operator) aircraft can be flown out-of-sight and at high altitudes, while other men on the ground track it by electronic devices.

Launchings of the "Firebee" have been successfully performed from the ground as well as from the belly and wings of twin-engine "mother" planes at Holloman ADC. Then it streaks ghostlike over the countryside, eerily obeying commands transmitted miles away.

Early in the "Firebee" project, it became apparent that its fullest utilization would depend on a practical recovery system. Hence Ryan and Air Force technicians developed a two-stage parachute deployment to decelerate the drone from speeds up to 600 miles an hour and lower it safely to the ground (RYAN REPORTER, Feb. 1, 1953). Activation of the parachute recovery system does not always depend on a command from the remote control operator. The smaller "drag" chute and the larger main chute

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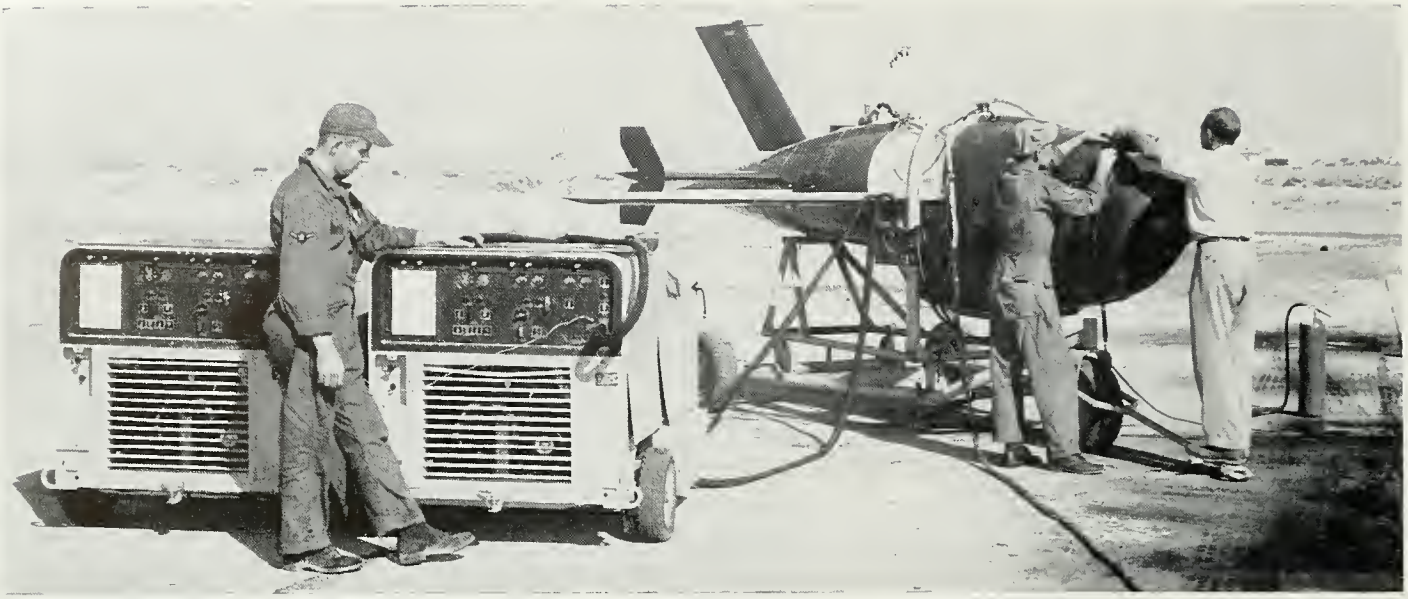

Before flight, "Firebee" is prepared for ground run-up of engine. Auxiliary unit provides electrical power to start J-44 engine.

flare out from the tail cone automatically in event of a target hit, loss of radio wave carrier from the remote control station, or engine failure.

Incidentally, although most of the "Firebee's" flights have been made with the Fairchild J-44 engine, it has also been tested with the J-69 Marbore II jet, developed in France by Turbomeca and slated for manufacture in this country by Continental.

Construction of the drone is of aluminum, magnesium and stainless steel in five major assemblies — fuselage, nacelle, wing, empennage and parachute container (tail cone). The assemblies are easily assembled or dismantled in the field as result of incorporation of many novel features.

The wings attach to the fuselage with only four bolts, all readily accessible. The nacelle containing the engine is hinged to allow ready access to the interior of the compartment. And like the wing, the tail assembly is attached with four self-aligning bolts.

In a sense, the problems of developing the "Firebee" were greater than these of designing a man-carrying jet plane. In addition to the normal aerodynamic factors, Ryan engineers had to cope with the eccentricities of a remote control system, an autopilot system and a parachute recovery system.

The first glide flight tests of the "Fire-

(Continued on page 22)

Undamaged "Firebee" lies on New Mexico desert floor following parachute drop. Air Force crane and trailer retrieves drone.

Ryanite Vivian Haynes places parachute decal on "Firebee" to indicate another successful recovery after test flight.

Aluminum chips fly as Kerry Conely (left) directs a form block through the Orton shaper and John Mackay tilts the mobile cutter.

UNIQUE SHAPER

New machine simplifies tedious task with tiltable cutter

RYAN will save thousands of man-hours a year with a new machine which is the only one of its kind in the West. Called a variable tilt shaper, this valuable device slashes seven-eighths of the time required to machine form blocks.

Designed and built by the Orton Machine Company of San Francisco, the $6,000 tool successfully tackles one of the most tedious and time-consuming jobs in the aircraft industry. This is the machining, to varying angles, of the edges of cast aluminum form blocks used to fabricate bulkheads, frames, gussets, ribs and many other structural parts for aircraft. Ryan makes hundreds of these form blocks each year so that the savings which will be realized will reach substantial proportions.

Form blocks are slabs of cast aluminum alloy which are placed in hydropresses to act as the bottom dies against which the aluminum sheets are forced by the descent of the press's rubber-faced ram. Since the parts formed must fit into aircraft which have tapered fuselages, wings and other components, the edges of the form blocks have to be cut to varying angles. Usually, the form blocks are two inches thick and the angle of

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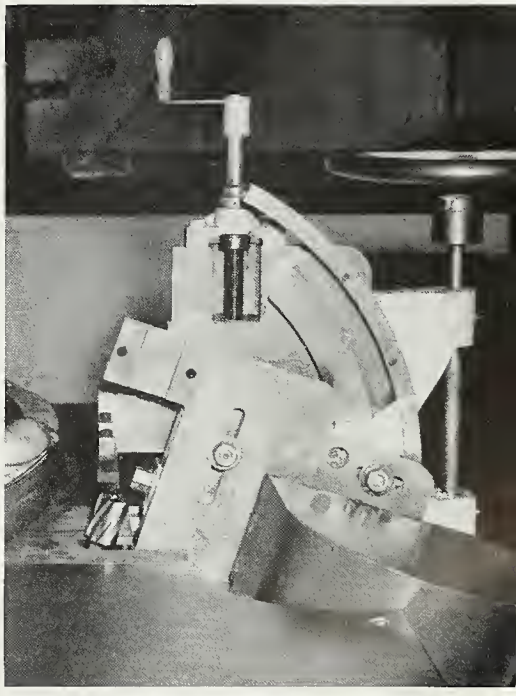

Key to machine's success is method of mounting cutter and motor on an outer quadrant which slides over the fixed inner quadrant by control wheel action.

In vertical position, the Fairchild J-44 jet engine is fitted with sheet metal outer cowl which doubles as pressure chamber and frame structure for the bearing supports.

MIGHTY MIDGET

A TRAIL of queries have been left in the jet wake of Ryan's new "Firebee" pilotless target planes as they have streaked across the desert in numerous test flights. Recently released photographs of uninhabited "Firebee" flights have evoked numerous questions concerning its power plant, guidance system and recovery apparatus.

With the lifting of secrecy surrounding the "Firebee," it can now be disclosed that the Fairchild J-44 engine, is the power plant which has sped most of the Ryan target drones on their swift, lonely flights. A limited number have been powered by the J-69 Marbore II jet engine, developed in France by Turbomeca and licensed for U. S. manufacture by Continental.

Described as the most powerful engine of its size to be placed in production, the remarkable Fairchild J-44 delivers 1000 pounds of thrust with a weight of only 300 pounds. It is a compact, cylindrical power package occupying 72 inches in length and 22 inches in diameter.

In the J-44 design, Fairchild engineers have accomplished several ingenious objectives which will add new concepts to jet engine versatility. In addition to its high power-weight ratio, the engine embodies unique features which make it extremely compact, simple, easy to maintain and free from critical materials.

As George F. Chapline, Fairchild Vice-President, expresses it, "With the J-44 design the turbo-jet is reduced to its basic structural requirements. The outer sheet metal cowl forms both a pressure chamber and a frame structure connecting the two main bearing supports. Just as the monocoque fuselage replaced heavy framework in aircraft design, a simple sheet metal monocoque structure replaces

heavy castings for most of the engine's length.

"We are convinced of startling production advantages in monocoque construction which show no characteristics that would limit their application to larger power plants. For example, turbo-jet engines of 7000 pounds thrust and weighing 2000 pounds could be built with a raw materials conversion loss of less than 20 percent."

To meet the combined needs of a reliable engine which would stand up to frequent re-use after parachute recovery of the Ryan "Firebees" and yet be economical to produce for expendable use in warfare, Fairchild designers dispensed with all machined parts which could be avoided. Critical materials were also restricted to those uses where they are absolutely essential. The rotor shaft itself is a light-weight, seamless tube.

The J-44 can be mounted in two ways. Due to its inherent rigidity, it may be installed without any aft support in a cantilever mount attaching to the front of the compressor section, as it is attached in the Ryan "Firebee." It can also be trunnion mounted at the sides of the compressor section with an aft stabilizer at the rear bearing support frame. This type of installation would be used to mount the engine under a typical transport airplane wing as a pod unit. Because its outer shell is a smooth, streamlined enclosure, no additional cowling is needed for most installations.

Requiring only minimum services from the air frame, the J-44 is designed to be a self-contained power plant. It has its own oil storage and requires no oil coolers or external oil lines. Internal oil capacity for more than 10 hours of operation can be provided.

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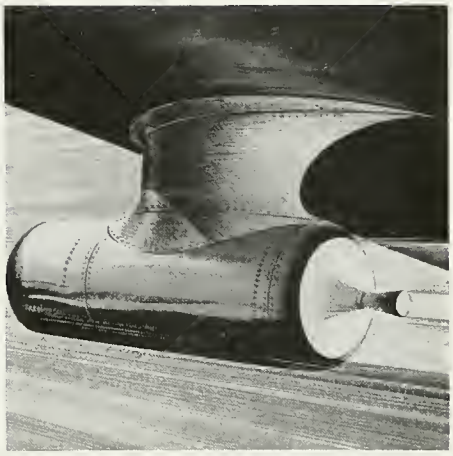
Bruce Smith, Ryan Engineering Director (left) and George Chapline, Fairchild Vice President, confer on teaming J-44 with Ryan's "Firebee" pilotless plane.

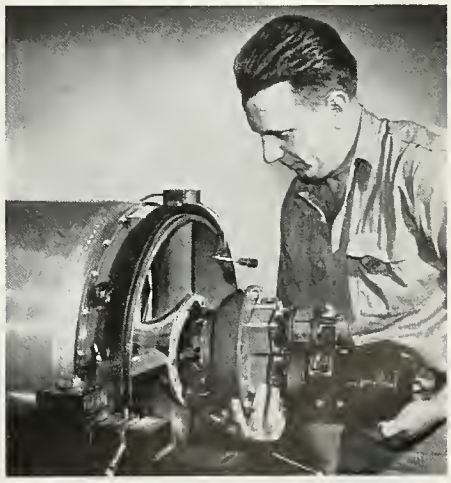


Designed as a self-contained unit, the J-44 can be trunnion mounted as a pod under the wing of a transport plane to boost payload and cut operating costs.

Within a smooth, streamlined package, the new Fairchild J-44 generates 3 pounds of thrust for each pound of weight. Monocoque design eliminated many structural parts.

Due to its inherent rigidity, the J-44 may be installed without aft support in cantilever mounting. This is mounting method used by Ryan "Firebee" drones.

Fairchild's amazing new turbo-jet sparks Ryan Firebee's startling performance



Controls, fuel pump and electrical unit are mounted on accessory section which can be quickly removed by a single man.

During World War II, tactical drones were used in various ways. Photo shows TDR-1 remote control plane fitted with 2,000-pound bomb. Note television camera in nose.

TACTICAL DRONES

(Continued from page 1)

such obsolete planes, equipped with television "eyes" and guided by mother planes, to demolish enemy targets, including two Japanese ships in 1944. A television receiver in the mother plane showed the course being taken by the drone and helped guide it to its objective with pinpoint accuracy.

When the Navy's air strength was at low ebb early in World War II as result of heavy losses in the Pacific, another drone, the two-engined TDR-1, was developed by the Interstate Aircraft Engineering Corp. Its designer was Dave Williams, now a Ryan engineer.

This highly secret project was originally designed to serve as a torpedo assault drone to attack Japanese warships. The wingspan was 48 feet, weight was about 8500 pounds, and the engines were 240 h.p. Lycomings. About 125 were built in Interstate's plant in DeKalb, Illinois. After takeoff from the ground, the TDR-1 was to be guided to its target by a mother plane remaining safely out of enemy firing range. A television camera was mounted in the nose and the remote control plane followed the drone's progress by means of a television receiving set.

No TDR-1s were actually used against Japanese vessels, but Williams recalled that, equipped with bombs, about 40 of these drones launched a successful attack on an enemy held island in the Pacific. The remainder of those produced eventually were employed as targets.

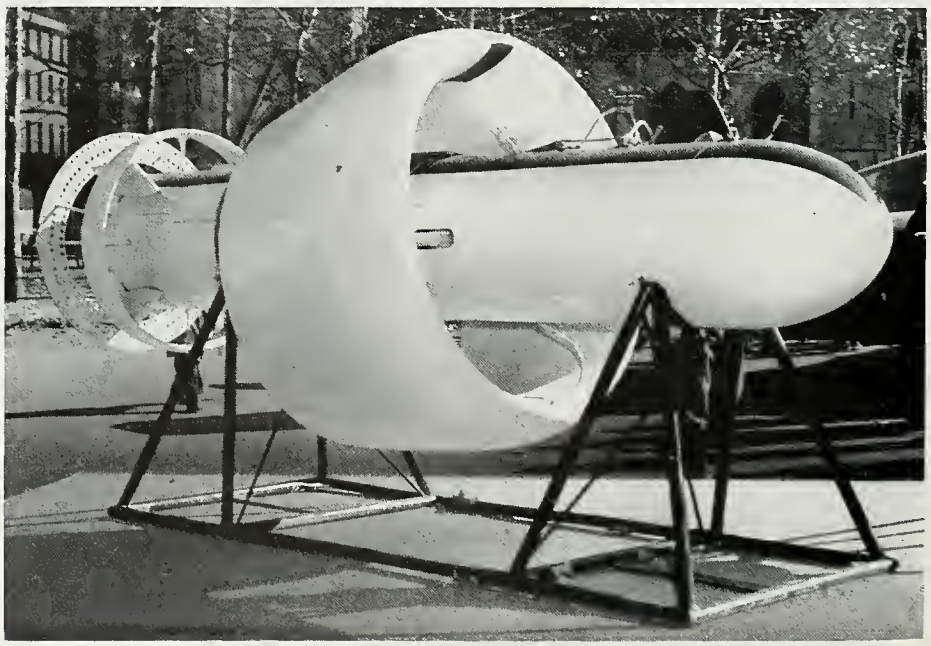
The Air Force also used television controls for a limited guided missile project in Europe in World War II. Glide bombs, weighing 2,000 pounds, designated the GB-4, flew several such missions against pin-point targets in August and September of 1944. These included the E-boat pens at LeHavre, the submarine pens at LaPalice, France, a railroad bridge at Ravenstein, Holland, electrical apparatus at Duren, Germany, and an oil refinery at Salzbergen, Germany.

The GB-4 consisted of a standard ordnance bomb attached to an airframe equipped with instruments for maintaining the bomb in a stable glide after it dropped away from the "mother" control plane. It was equipped with a

(Continued on next page)

Ground pilot of radio-controlled B-17 is shown here "bringing in" his plane.

Among numerous radio-guided missiles which have been developed in the United States in recent years is this Air Force VB-10 "Roc," created by Douglas Aircraft Company.



television transmitter and a radio receiver. The transmitter "saw" where the bomb was going and sent a picture back to the operator in the control plane. Then the operator sent out radio signals to the GB-4 which guided the bomb either in a perpendicular or horizontal direction.

THE remote-control operator selected his target and kept that point in the center of his television screen. He continued to guide the bomb to the target even though the control plane had turned around and started back to base.

In another application, outmoded B-17 Flying Fortresses and B-24 Liberators were stripped of all excess weight, were loaded with 18,500 pounds of high explosive and flown by the Air Force into targets by remote radio control from a mother plane. These secret missions came to be known as the "War Weary" guided missile project, an accurate description of the robot planes used.

The "war weary" B-17's and B-24's during September, October and December, 1944 flew considerable distances to reach their targets, ranging from 320 to 376 miles. Hit were the submarine pens at Helgoland, an oil refinery at Henningstadt, Germany, barracks and shops at Helgoland and military objectives at Herford, Germany.

Successful trials were accomplished by the Air Force during the war of a type of television carrying radio controlled guided bomb known as ROC (VB-10), developed by Douglas Aircraft Company, but there was no opportunity to test it in actual operational use.

A drone is operated, either from the ground, or from a mother plane, with a small box that contains a miniature control stick, push-buttons and toggle switches. The tiny control stick can be moved in four directions to control dive, climb, left turn and right turn. Manipulation of a push-button will bring the drone plane back from a turn into a straight heading. The toggle switches control other operations, including throttle on-off, cowl flaps open-close, landing gear up-down, brakes on-off, auto-cruise (throttle), and direct rudder left-right.

Besides the control unit, the radio remote control system consists of a radio transmitter-modulator at the transmission point, and a radio receiver-selector unit and a relay control unit in the drone itself.

An auto-pilot keeps the drone on any desired heading, and brings the plane back to position when it is inclined to stray away from such heading. It also maintains the drone accurately stabilized about its roll, pitch and yaw axes.

In 1936, the Navy decided that it needed anti-aircraft gunnery targets for its ships which would more realistically simulate the actions of attacking enemy planes than the conventional sleeve-type target. Obviously, such a target would be a drone, a plane that could be put through combat maneuvers by radio remote control.

Single-engined biplanes were converted into drones, which had no automatic stabilization system. Their controls were actuated by direct signal, and it was necessary for the operator to effect a continuous and difficult coordination of the engine speed, ailerons, rudder and elevators. Since these early days, great advances have been made through development of a workable stabilization system and improvement of the entire radio remote control apparatus.

By June, 1938, radio controlled drones were turned over to the Fleet at San Diego, and two months later, one of these drones was used as a target for ship gunnery practice exercises by the aircraft carrier Ranger.

A complete re-evaluation of carrier anti-aircraft artillery and fire control apparatus and procedures was found necessary as a result of this first use of an actual plane as a target. The Fleet's gunnery training program was radically modified and the need for drastic improvements in equipment was shown.

In March, 1942, a television "eye" was placed in a torpedo-carrying TG-2 to transmit a picture of the target back to the control plane. This aircraft performed the first successful simulated attack on a destroyer maneuvering at 15 knots. The control plane was 10 miles away when the TV "eye" in the drone picked up the destroyer and transmitted the picture to the screen in the control plane.

Drones have had other uses, besides those geared to target destruction. For instance, in January, 1944, radio controlled Hellcats were employed in simulated combat tests to determine the degree of inflammability and fire hazard that might develop in connection with the possible ignition of jettisonable fuel tanks. These tests were performed under gunfire, and the Navy was able to get its information without risking the lives of pilots.

AFTER the war, tactical drones were assigned to the Bikini atoll bomb tests in 1946. Four radio-controlled Hellcats were directed by mother planes through the great radioactive cloud mushrooming from the bomb burst. Three of the planes came out of the cloud saturated with radioactivity, while the fourth crashed.

One of the three was hurled some 6,000 feet vertically by the powerful updraft, and the controlling plane on the other side of the cloud lost it until it was located by the carrier Shangri-La 55 miles from the blast scene. The control plane was vectored to it by the Shangri-La, and the wandering drone was brought back to Roi Island in the Kwajaleins with the other two for examination. Air Force B-17's also flew the Bikini atom bomb area without pilots.

Other drones went through a steam and smoke column 9,000 feet above the explosion's "waterspout" in the second test, and brought back valuable data on velocity, acceleration and altitudes affected by radioactivity, as well as air samples from the atomic blast column.

Drones themselves are being constantly improved to enhance their performance characteristics and more closely parallel the tactical use of enemy planes. Such improvements have included the addition of two external turbo-jet engines to increase altitude, range and speed.

As a form of guided missile, a drone plane might well be classed as a robot Kamikaze. The "suicide" plunges of such aircraft in future combat would be performed without loss of American lives. That is the one bright hope of "push-button" warfare.

ON THE COVER

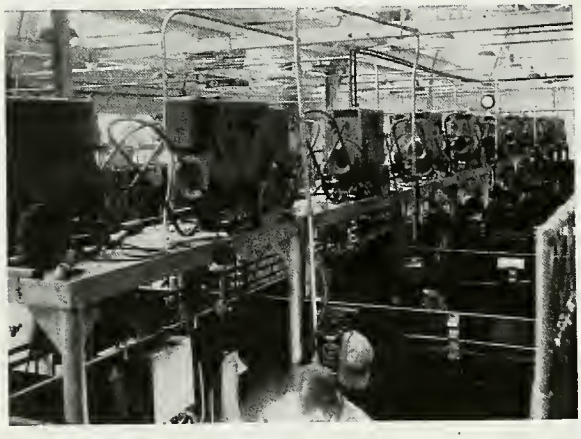
Shooting from one big aft fuselage into another, Ryan cameraman Bob Stewart catches Lionel Walker (left) and Marian Maley putting the last touches on one of the big structures and frames them in a circle of light from mercury-vapor fixtures. Largest components ever built at Ryan, the aft fuselages are almost completely assembled by riveting in huge steel fixtures. Most of Ryan's spacious final assembly building is devoted to their urgently needed production.

DESIGNED FOR WELDING

Welding working conditions have never been so good as they are in Ryan's new self-contained welding building. In the most modern facility of its kind, Ryan has grouped 29 heliarc welding booths and provided the operators with unexcelled space, cleanliness, lighting, ventilation and welding equipment. As a direct result, welding efficiency has jumped 15 percent over former high standards in just 90 days.

The new building is a metal sash and saw-tooth structure which was suggested by Ray Ortiz, Ryan manifold superintendent and Bill Kupilik, welding general foreman. In it are located the 29 welding booths which perform the heliarc flange seam welding on Ryan exhaust systems for Pratt and Whitney engines, Douglas, Boeing, Convair and Fairchild transport planes and Piasecki helicopters, among others. Normally, a hot, noisy and tedious job, the new facilities have made the heliarc assignment a much sought after type of work.

The 29 General Electric 150-ampere motor-generator sets, which supply the welding current, were installed on overhead platforms which are approximately seven feet high. These sets lend themselves to overhead installation because they are compact and relatively light-weight. Platforms are made from welded steel frames and wood and are located along the rear section of each booth.



Every welding booth was equipped with the latest facilities for accomplishing the work. Ryan-designed automatic timers were installed to relieve operators of all responsibility for controlling the flows of argon gas and water. Remote foot controls are used to allow the welders to regulate welding heat while the work is in progress without the necessity for stopping to adjust the machines. Ryan devised a system of remote switch controls, for turning the motor-generators on and off, which are readily accessible to the operator.

These innovations have given welders more working space by taking the bulky motor-generators out of the booths and have eliminated the ever-present and inconvenient electrical cables which were formerly a floor hazard. In addition, the noise created by the seven-and-a-half horsepower motors as they whirred at 3500 r.p.m. has been substantially reduced. Most important, the turbulent flow of air, generated by the motor, has been entirely removed from the floor area where it interfered with good welding operation. This turbulence blew the flow of protective argon gas away from the weld area. In order to counteract this effect, welders had to step up the flow of gas, thus wasting quantities of this valuable product.

For maximum natural lighting and ventilation, the steel building is paneled with a continuous section of high windows. An efficient system of artificial lighting fixtures provides comfortable illumination for night shift work.

A cascade system is utilized to provide all booths with a supply of argon gas and two booths with oxygen and acetylene. The argon is piped from a central storage facility which is supplied by means of tank truck delivery service. This method cuts gas costs in several ways.

First, the argon can be bought in larger and less expensive quantities. Second, the costs for handling individual bottles for each booth are eliminated. Third, extra space is obtained for each booth by the removal of the bottles from the working area.

Argon gas costs are a material item in Ryan welding operations because Ryan is one of the largest, if not the largest, consumer of this gas in the United States, using $192,000 worth each year. It is interesting to note that ten years ago practically all of this type of welding was accomplished at Ryan by oxygen-acetylene methods. Today, Ryan has converted the entire production of this type of welding to modern heliarc techniques. Oxygen-acetylene is used only for cutting operations.

For necessary maintenance and repair requirements, the raised motor-generator sets are quickly available. The front curtain bars in each welding booth are hinged and pinned so they may be swung aside. By bringing a lift truck into the booth, the motor-generator can be lifted down and removed to the electrical maintenance shop for work. Another unit may be installed in its place so that welding is not unduly interrupted because of repair necessities.

1952 Business Year At Ryan

(Continued from page 6)

usage. When a company reports a profit, most people think of the sum as an actual aomunt of cash — a bag of money stored away in a vault — which is left over and above the company's needs.

Actually, profits are the costs *paid by the customer* for the *use* of the machines, buildings and other *tools* needed to *make the products* he buys.

Profit is made up of two things — (1) the take-home pay, or dividends, of the stockholders and (2) what is reinvested in the business.

Of every dollar of "profit" accruing to the owners of the company this year, 22c was paid in dividends and 78c reinvested. Funds reinvested went right back into the business in the form of new machines and equipment, to pay for research and to continue progressive growth.

In the 1952 fiscal year the cost of using the tools of production at Ryan totaled $878,359. Of this amount the take home pay of the owners was $196,921 and the amount reinvested was $681,438. This is an average of about $196 and $681, respectively, for each of Ryan's one thousand owners who have invested an average of nearly $6000 each in stock (a share of ownership) in the company.

When stated in personal terms for the individual, profit may be more easily understood. The difference between the weekly paycheck and day to day living expenses is what enables a man to save and build for the future.

The public's real concern should be that the company may not make enough "profit" to keep its plants and manufacturing equipment up to date so as to provide secure jobs for its workers.

Now that we've discussed the company's income and costs let's examine its balance sheet which shows what it *owns* (assets) and what it *owes* (liabilities).

F. CURRENT ASSETS . . . $22,223,565.

Cash, accounts receivable, inventories, work in process and other assets which can be converted into cash (Current Assets) totaled more than $22 millions.

G. CURRENT LIABILITIES . . $17,948,658.

On October 31, 1952 Ryan owed large sums to suppliers for materials and services, to the federal government for taxes and to banks for money which we had

borrowed in order to provide sufficient money with which to operate the business. As these current liabilities totaled $17,948,658, the difference between current assets and current liabilities left us with $4,274,907 as our working capital or funds available for current operations.

H. and I. Items "H" (Other Assets) and "I" (Other Liabilities) are accounting entries of such minor nature that an explanation is superfluous. The major item of $148,834, is the amount set up for workmen's compensation risks.

J. NET FIXED ASSETS . $1,757,737.

This figure is the difference between the original costs of all our buildings, machinery and other facilities (totaling $4,274,804) and the amount of "wear and tear" on these facilities during the years since they were originally purchased, ($2,517,103). The $1,757,737 represents the value carried on the books for our plant, production equipment and other facilities.

K. STOCKHOLDERS EQUITY . . . $5,898,510.

The greater part of this sum, totaling $4,945,878, is the amount of "profits" which have been accumulated during the past 22 years and retained for use in the business. It is this continued reinvestment of funds, plus the stockholders original investment of approximately a million dollars, which enables the company to provide jobs for more than 4000 workers.

The stockholders equity of nearly $6 million is not in cash but is in buildings, equipment, inventories of raw materials and work in process, without which the company could not remain in business, for these are the things essential to a growing concern.

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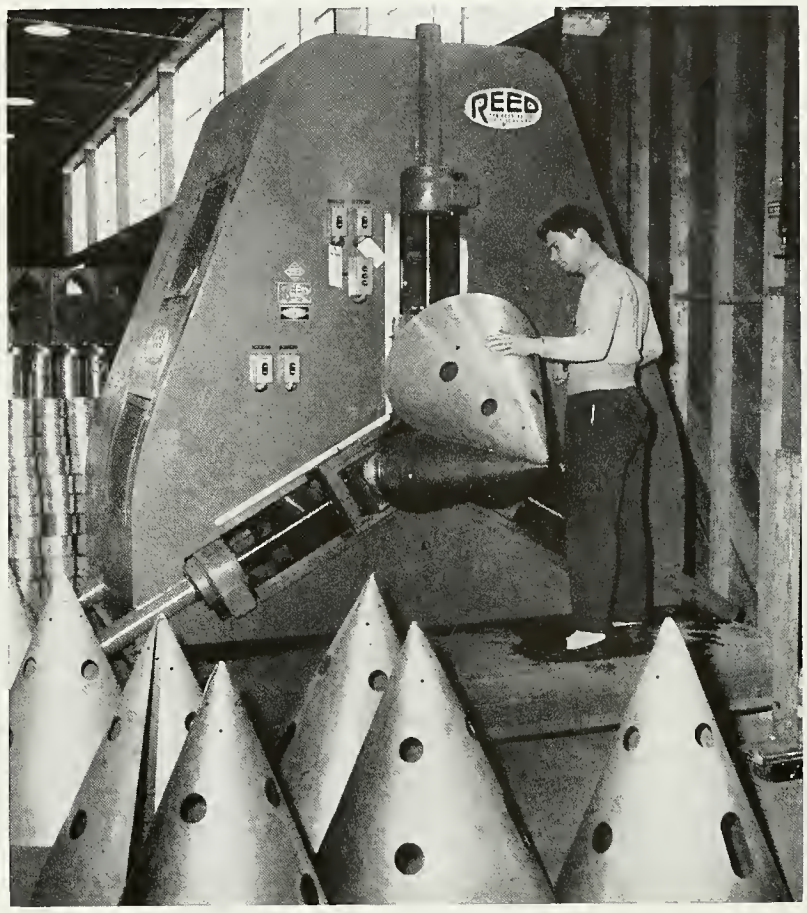


CONE ROLLER

With a powerful new machine, Ryan will greatly reduce manhours in building inner exhaust cones for jet engines. Designed by the Reed Engineering Company, the ingenious device rolls heavy stainless steel sheets into pin-pointed cones in a matter of minutes.

Inner exhaust cones must be as smooth and symmetrical as the surfaces of a 1200 mile-an-hour airplane. They straighten the flow of the hot, turbulent exhaust gases as they rush at that velocity from the spinning turbine buckets of a jet engine. Their fabrication must meet the demands of supersonic service.

Heretofore, Ryan has built the inner cone in two sections; a truncated cone, or frustum, and a small cone. The frustum was rolled on a standard rolling machine with parallel-sided rollers. It was not possible to roll a complete cone on these standard rollers. Consequently, a small cone had to be formed in a die and then attached to the frustum to complete the large inner exhaust cone configuration.

After both the cone and frustum were heliarc-welded along their longitudinal seams, they had to be assembled together in a precision jig and welded, by hand, around their transverse seam. This required 22 inches of careful welding and a substantial amount of labor in grinding the weld seams smooth and fitting the parts together.

With the new cone roller, many of these time-consuming operations have been eliminated. A sheet of pattern-cut stainless steel is placed between the tapered rolls of the machine, the pushbuttons are depressed and out rolls a complete cone. The unit is placed on an automatic heliarc welding machine and the longitudinal seam is accurately welded in one pass. Twenty-two inches of hand welding are eliminated. No tedious forming of the small cone is necessary. All fitting together of the sections is avoided and the laborious grinding operation is no longer required. The resultant product is sounder structurally and better in quality. It is a one-piece affair without the extra weld seam which presents opportunities for defective weld structure.

The Reed cone roller will roll any pointed cone in which the included angle is greater than 24 degrees—the angle occupied by the three rollers, when contracted together.

THE BEE WITH THE ELECTRONIC BRAIN

(Continued from page 14)

bee" without power were made exactly two years ago this month, and the first powered flights were performed in the summer of 1951. The basic research and test program has advanced to the point that Ryan has just completed training a group of key Air Force and Army ordnance officers and technicians in assembly, operation and maintenance of "Firebees" preparatory to "operational suitability testing" of the drones at several bases.

To date, the principal mission of the "Firebee" which has been revealed is its use as a target for modern defense weapons.

Air Force crew man adjusts nylon webbing riser from which "Firebee" is suspended in parachute recovery. Note sharply swept back configuration of wing and tail surfaces.

KING-SIZE COMPONENTS

(Continued from page 11)

could be accommodated within the confines of the pod.

An important factor in utilizing space more advantageously has been the design and construction of mobile racks which are tailored to the large components. Outstanding examples of these are the racks used to carry the 23-foot longerons and 7-foot diameter bulkheads. These facilities serve not only as splendid carriers but double as efficient temporary storage devices which occupy much less space than make-shift dollies or trucks.

By extending the upper deck of the platforms surrounding the big "45" fixtures extra space was gleaned for the temporary storage of longerons, headers and large aluminum sheets. Previously these bulky items were stored on the factory floor where they took up valuable space from production activities.

After final assembly in the "45" fixtures, the aft fuselages are placed on a mobile production line and fitted with floors, clam-shell cargo doors and hydraulic systems. From this line they go to several big pressure test jigs to test them for high altitude service.

Every opening is tightly closed and air is pumped into the structures until six-and-a-half pounds per square inch is reached. Two men, inside of the fuselage, search for leaks which may be caused by air escaping from tiny openings in seams or joints. These leaks can be detected by the hissing sound of the air as it issues from the metal fuselage. Each opening is sealed by means of a sealing compound which is applied from a pressure gun. On the outside of the structure another operator controls the air flow and watches a flowmeter and pressure indicator to determine when the fuselage has been properly sealed. He then communicates with the two inside men through telephone and they prepare to emerge. Decompression takes about fifteen minutes in order that the men suffer no discomfort from the effects of the changes in pressure.

Every tenth fuselage is given a test of 10 p.s.i. to check its structural integrity. At this pressure, almost a million pounds of force is exerted on the inside walls of the fuselage structure. The force is equivalent to the weight of a locomotive on one of the cargo doors alone. This pressure is about the same unbalanced force which would be exerted upon the Stratofreighter if it were flying at an altitude of 30,000 feet and were pressurized to maintain an 8,000-foot atmosphere.

UNIQUE SHAPER

(Continued from page 15)

the edges changes constantly, but not uniformly, along their entire contour.

Heretofore, no machine has been available for cutting the edges and the form blocks have had to be made by hand. First, the slab was cut out with a Tannewitz band saw, using a steel template to outline the cut. Then, the template was attached to the form block and it was filed by hand along its edges in conformity with the markings indicated on the template. This involved a laborious process of filing and constantly checking the results with a protractor. Accuracy depended upon the skill of the workman. A typical form block, such as that used to make the door ribs for the Boeing C-97 Stratofreighter, required three days to file the edges.

With the new variable tilt shaper, this job can be turned out in only three hours. Two men operate the machine. One feeds the form block into the rotating cutter while the other turns a large control wheel which changes the angle of the cutter as the work progresses.

The success of the machine in accomplishing its task is due to its unusual design. It consists of a vertical cutter which is suspended slightly above the surface of a steel table by means of a circular mounting. The cutter head unit and 5-horsepower electric motor are mounted on an outer quadrant which slides over an inner quadrant on bronze ways. The inner quadrant is mounted on the frame of the machine. By turning a control wheel, which actuates a worm gear and pinion, the outer quadrant can be rotated over the inner quadrant. No lock is required to maintain its position because of its substantial design.

The cutter head unit is so located that the top edge of the cutter is at the exact center of rotation of the outer quadrant. Consequently, as the angle of the cutter is changed, the top edge remains stationary and the cutter rotates around the point where the top edge contacts the form block. In this way the angle of the machining can be varied precisely from an exact line which is the top contour of the form block.

As the work is machined, one operator continuously adjusts the angle of the spinning cutter by bringing the pointer on the machine's protractor scale into conformity with the readings indicated on the template.

A guide, mounted on the non-tilting inner quadrant, is located immediately above the cutter. The other operator feeds the form block into the cutter by bringing the template against this guide which is in full view.

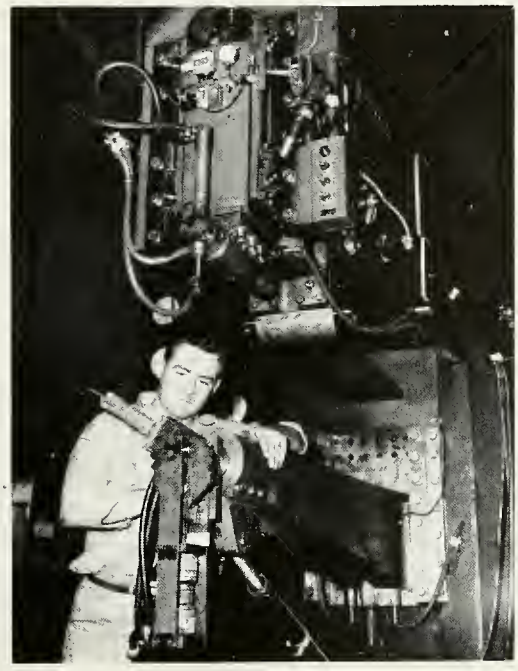
The machine will cut any angle from 45 degrees under to 30 degrees standing. An adjustment on the inner quadrant is provided which raises or lowers the point of rotation of the cutter so that blocks up to six inches thick can be machined. Practically any shape of block can be processed as long as it is of uniform thickness.

Accuracies obtained are exceptionally high because the circular mounting of the machine magnifies the operator's control. A slight change in the angle of the cutter, which would not be perceptable to the eye, is easily observed on the protractor scale which is a segment of a very much larger circle.

ROTATING ELECTRODE

Production is the mother of invention at Ryan. A striking example of this is the new Ryan-designed rotatable electrode. Conceived by plant engineers as an accessory for large spot welding machines, this special electrode was born from the necessity for speeding production of Ryan's huge external wing tanks.

Largest ever designed, the Ryan fuel cells are of spot welded aluminum alloy construction. Not a rivet mars their sleek exterior. To speed production of these unusual tanks, Ryan production experts have installed tracked conveyor systems to eight large spot welding machines.



By making the lower electrodes of these spot welders rotatable, it is possible for one man to push the tank sections between the 60-inch "jaws" of the big machines with ease. Without the retractable electrodes, it would require four men to lift the heavy, unwieldy tank sections over their interior bulkheads as the spot welding is shifted from one seam to another. Because of the massive bulk of the machines, it is not possible to employ an overhead crane system like that used to load the sections on the tracked dollies.

Operated by foot control, the rotatable electrode swings from a vertical to horizontal position to provide 10 inches of added clearance between the electrode arms. The movement is accomplished by a hydraulic cylinder and piston which pulls a yoke down. A pin in this yoke is keyed into an "L"-shaped slot in the lower electrode assembly. The copper electrode is mounted on a horizontal shaft which is firmly attached to the electrode arm. As the yoke descends, it rotates the electrode into a horizontal position.

In addition to the rotating movement, the electrode is actuated in another direction. The yoke is wedge-shaped, laterally, and moves in and out against steel roller bearings as it rotates the electrode. Thus, as the electrode moves into the upright position, the wedging action of the yoke pushes it tightly against the electrode arm to form a firm electrical contact.

Tests, made of this joint, show that it has a 100 percent electrical efficiency, equivalent to the current carrying efficiency of a one-piece electrode and arm assembly. This is an important advantage because 100,000 amperes flow through this electrode. Even a slight resistance, caused by poor fit or faulty alignment would seriously reduce this welding current.

With an eye on the practical aspects, Ryan tool designer H. F. Wallen designed the assembly so that it would operate on the same line water pressure which is used for cooling the electrodes. The hydraulic cylinder converts this 50 pounds per square inch pressure into 400 psi which imparts a fast, positive action to the rotation of the electrode.

Nationally Known Engineer Joins Ryan Organization

Another engineer with a national reputation has joined Ryan. He is Curtis L. Bates, for more than ten years associated with Northrop Aircraft, Inc., in the development of that company's most advanced planes, including the famed P-61 Black Widow, the B-35 and B-49 Flying Wings, the F-89 Scorpion, and other aircraft. He also developed the launching sleds for the Navy Loon.

Bates has been named assistant director of engineering, reporting to Bruce Smith, director of engineering. Most recently, Bates was director of mechanical design at Northrop.

A graduate of the University of Detroit with a degree in aeronautical engineering, Bates began his aviation career in 1929 as test engineer at the Buhl Aircraft Corp., Marysville, Mich. He was director of aeronautical engineering and acting dean of Lawrence Institute of Technology, Detroit, from 1932-36, then came to Southern California.

Curtis L. Bates, left, nationally known engineer, has been named assistant to Bruce Smith, right, Ryan director of engineering.

Before joining Northrop in 1942, he served Douglas Aircraft at Santa Monica, Timm Aircraft at Glendale, and was chief engineer of the Aero Industries Technical Institute, Glendale, for four years. He also served in Sweden as structures engineer on Swedish military airplane developments.

JUNIOR ACHIEVEMENT

(Continued from page 7)

During the business meeting, when the regular activity is carried out, methods may be discussed in which production is speeded up or the quality of the merchandise improved. But, unlike other businesses, the Achievers can utilize these methods when they go to work on their product. Through this system of "learning by doing," the student gains a practical knowledge of business principles. The Achievers, in other words, serve both as executives and workers, thereby obtaining an accurate picture of the problems of both labor and management.

To offer an incentive to the students, a number of prizes and awards are given by many organizations. For instance, the New York Stock Exchange each year offers a trophy to the Junior Achievement company which gives the best financial statement when the company liquidates, regardless of whether it makes a profit or comes out in the red. But even if a company does not return a dividend to the stockholders, the members can then analyze their mistakes, and therefore they often learn just as much as they would have, had they made a profit.

There are also many scholarships offered by colleges, universities, and private organizations to those Achievers who prove in their company's activities, their quality of leadership.

This program also helps the businessman who sponsors it by promoting better public relations. The students learn the business principles of the sponsoring companies, and the Achiever, after he graduates from high school, often is employed by the same company that sponsored him in Junior Achievement.

Students in this program, therefore, gain a general understanding of business, learn the part that effective advertising plays in the operation of a successful business, and learn the importance of good relations between labor and management.

Because of these reasons, I am talking about Junior Achievement in my classes at school, in clubs, and to my friends, explaining to them how it works and the many benefits that can be derived from it, and recommending this program to any student who wishes to learn, by first-hand experience, the workings of our great free enterprise system.

MIGHTY MIDGET

(Continued from page 17)

The engine's essential controls, fuel pump and electrical units are fitted on a removable accessory section. Power control is of the constant speed type. Electrical starting is provided by a starter-generator mounted on the accessory housing, or a compressed air starting system is available.

One of the beneficial features of the J-44 is the ease with which it can be serviced. Only a few dollars worth of conventional tools, obtainable in any hardware store, are required to service and overhaul the engine. The single exception to this is a special shaft-nut wrench which can be made in the average overhaul shop.

Simplicity of the design, typified by outboard bearings and self-contained accessory section, makes the power plant easy to maintain and overhaul. In installations where there is access to both ends of the unit, even major repairs such as replacing front or rear bearings can be made without engine removal. Accessories are conveniently located so that one man can remove them from their mounting pads or the entire section can be quickly replaced in the field.

Now being produced exclusively for Armed Services use, the J-44 is creating considerable interest in its potential capacity to boost payloads and lower operating costs for airline transports and other airborne craft when conditions permit its application to these objectives.

N. A. C. A. RESEARCH

(Continued from page 3)

powerplants are sorely needed for tomorrow's airplanes. Except for this new facility, the United States would not now have the research equipment so necessary for study of the largest turbojet engines now being developed.

An idea of the size of the new equipment can be gained from the fact that it has air exhausters with a total capacity of 825,000 cfs. It permits study, under laboratory control with full instrumentation, of the operating characteristics of engines under conditions which simulate flight throughout the range of altitude and speed desired.

Much of the scientific information developed by NACA research programs is

used directly by aircraft manufacturers, such as the Ryan Aeronautical Company, who are concerned with the fabrication of rocket engines, ram-jets and jet engine components. For example, NACA has recently published data relative to combustion, cooling and ignition of rocket motors.

THESE studies have disclosed that pulsating propellant flow is a particular problem in rocket motor behavior, requiring special instrumentation for proper analysis. NACA designed and constructed an electro-magnetic flowmeter which is use to measure the instantaneous flow rates of liquid rocket propellants. This instrument will measure rapid variations in flow rates not detected by previous instrumentation and may be used with a number of fluids of widely varying properties. It responds to both positively or negatively directed flow.

Another phase of NACA's rocket motor investigations, interesting to Ryan, is the problem of cooling a liquid propellant rocket engine. This is a challenging problem which must be solved if higher energy propellants with higher combustion pressures are to be used to obtain superior performance. NACA has arranged for studies to determine the heat transfer and frictional pressure drop properties of nitric acid flowing in tubes, as used with regeneratively cooled engines.

The NACA's general investigation of internal-film cooling includes studies wherein a coolant film is formed between the hot gases and the duct wall to maintain the wall at lower temperatures. The experimental data from these tests will be coordinated so that a prediction of film-coolant requirements for special cooling problems will be obtained.

One phase of the fundamental investigation was conducted in small diameter straight tubes having smooth inner surfaces with hot air flows at temperatures to 2,000°F. to determine the cooling effectiveness of water films on the inner surfaces. The film-cooling data obtained will be used to facilitate the estimation of the flow of coolant required to film cool a tube for a desired distance when the temperature and the flow of hot gas are known.

For the past several years the NACA has sponsored the development of high temperature ceramic coatings and the mechanisms of their adherence to metals, at the National Bureau of Standards. The work accomplished by the National Bureau of Standards has resulted in the successful ceramic formulae, A-417 and A-418, conceded to be the best coatings produced for use with corrosion-resistant, high temperature alloys and used extensively in volume production of aircraft components by the Ryan Aeronautical Company.

The National Bureau of Standards research established that hydrogen is a major cause of coating defects when a porcelain enamel is applied to a steel base. In an effort to determine the relative importance of the various sources of hydrogen, a study was made utilizing additions of deuterium in the form of heavy water in each of the five processes that are related to enameling operations. The gases given off when the coated specimens were fired were collected and analyzed with a mass spectrometer. The major source of hydrogen was discovered to be the dissolved water present in the enamel frit that was incorporated in the coating.

APPARENTLY, the water reacts with steel at elevated temperatures releasing atomic hydrogen, some of which is dissolved by the steel. During rapid cooling the steel becomes super-saturated with respect to hydrogen and molecular hydrogen forms in small fissures until sufficient pressure has accumulated to cause the coating to fail. Other sources of water, such as the acid pickle, milling water, chemically combined water in the clay and the frit quenching water were all minor sources of hydrogen.

In the investigation of adherence, the National Bureau of Standards also studied the role of cobalt oxide used to promote adherence of porcelain enamels to iron. A radio-active isotope of cobalt (Co^{60}) was used as a means for tracing the migration of cobalt during the firing process. It was disclosed that a cobalt-bearing phase is formed at the enamel-metal interface when a cobalt-bearing porcelain enamel is applied to an enameling iron and fired. This deposit varies directly with the severity of the firing and appears to be metallic rather than silicate or oxide.

A recent striking demonstration of the NACA's flight propulsion facilities was the simulated flight of a full scale ram-jet engine at 1100 miles per hour. The ram-jet, 17 feet long and 16 inches in diameter, was mounted in the test section of the world's largest supersonic wind tunnel which was brought up to an air speed of 20 miles per minute. Supersonic shock waves formed about the engine's air inlet as the fuel flow into the combustion chamber was increased. These shock waves were made visible by an optical device, known as a schlieren apparatus, which projected their image onto a viewing screen from a television camera.

AS the fuel flow was increased to provide additional thrust for maneuvers, there was an increase in internal pressures marked by drastic changes in the air flow pattern around the inlet until the strong shock wave began to move ahead of the inlet. Finally, a point of violent oscillation was reached. This "pulsing" could have serious consequences, if allowed to become severe, by either blowing out the engine's flame or causing destruction of the engine and missile through structural failure.

In continually developing research information, such as these examples portray, the NACA staff is making use of the unexcelled facilities at its disposal to advance the understanding of aviation science.

"FIREBEE" COURSE CONDUCTED

An eight-week instruction course in assembly, operation and maintenance of the Ryan "Firebee" jet target plane was recently completed by these Air Force, Army ordnance and artillery men at Alamogordo, New Mexico. At extreme left is Ronald Reasoner, Ryan engineer in charge of the instruction. In center, also wearing civilian clothes, is his assistant John McAllister Reece, also of the Ryan engineer staff.

RYAN AERONAUTICAL COMPANY
P. O. BOX 311
SAN DIEGO 12, CALIFORNIA

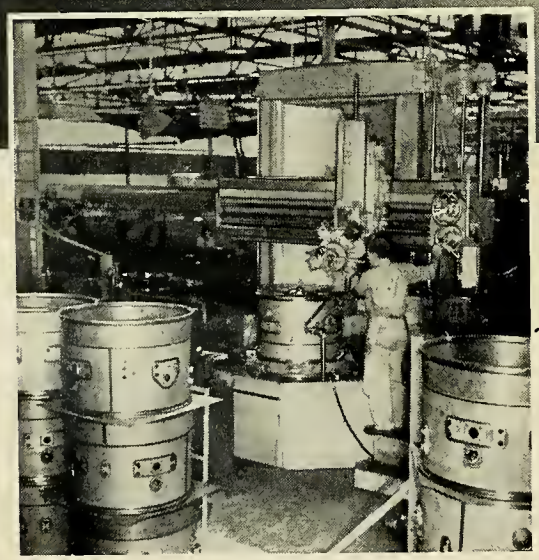
RYAN

Aircraft and Aeronautical Products

Leaders in High-Temperature Metallurgy

for

JET, PISTON AND ROCKET ENGINES



One of the keys to Ryan's leadership in high-temperature metallurgy and ceramics is its modern equipment, including some of the finest high precision machine tools and many of the largest electric resistance welders to be found in the country today. Such equipment, combined with the skills of Ryan research and production engineers, has put Ryan out in front in solving the "hot" problems of the aircraft industry.

Typical of the precision machines found at Ryan is this 64-inch Bullard vertical turret lathe, largest on the Pacific Coast. Ryan uses it and scores of other modern tools for large-scale production of heat-resistant products for jet, piston or rocket engines. You'll find Ryan metallurgists and research specialists in the forefront of high-temperature development work.

Ryan SINCE 1922

Metal Products Division · Jet Engine Components · Exhaust Systems · Rocket Assemblies

RYAN AERONAUTICAL COMPANY • LINDBERGH FIELD • SAN DIEGO, CALIF.

Ryan REPORTER

VOL. 14, NO. 3

2½ cents per Hour!

One fallacy all too prevalent in labor and certain professional circles is that American workers could materially improve their standard of living by taking a larger share of the profits which now go to the owners of business enterprises. This erroneous thought springs from the teachings of Karl Marx who argued that workers would never be free until they owned the facilities of production.

The truth of the matter is that if all the dividends paid to stockholders were added to the pay envelopes of the workers, the additional income would amount to "peanuts."

When visiting Ryan Aeronautical Company recently I had occasion to review the company's 1952 business year. I found that the total sum of money divided between the workers and the owners amounted to something over $16 million. The share of this which went to the workers amounted to almost 95%, while the owners received just over 5%. Four-fifths of the owners' share went back into the business; the remaining one-fifth was their cash payment. It amounted to only 1.2% of the $16 million available for division between the workers and the owners.

If all the stockholders' dividends had also gone to the workers, the additional money would only have been enough to increase hourly wages by 2½ cents per hour!

If the company were operated on such a basis, it would soon be destroyed, because without profits and dividends there would be no additional investments. Furthermore, the history of the communistic and socialistic nations shows that the workers never do own the production facilities even though they have been seized by the government. The State owns the facilities and the "Commissars" own the workers—the workers own nothing.

Even in Great Britain, when the Labor Party took over most of the key industries, the workers soon found that they had merely traded one set of bosses for another. Their wages remained low in comparison to the income of American workers employed under our free enterprise system. As a matter of fact, the pay of the British aircraft worker today is just about one-third that of the average worker in American plants.

Only by producing a larger economic pie can a bigger share of money be paid to both workers and stockholders. It does not matter how many billions of dollars there are in our collective pocket as a nation, we cannot buy more than we have produced. To live better, we must make more.

Production is the result of teamwork, not of conflict. For this reason, the nation will never achieve maximum production until people understand that the interests of workers and factory owners are identical and not opposed to each other. One group cannot prosper while the other suffers. Inflammatory statements issued by either group can only be harmful to both. Industrial peace is the greatest boon to everyone.

Charles O. Herb

Editor, MACHINERY Magazine

TUBE FORMING

Ryan uses paraffin to form tricky tubes as smooth as wax

AN unconventional method of tube forming is paying dividends at Ryan. Used to form odd-shaped, pressure-tight vent tubes for Ryan's big external fuel tanks, the unusual technique produces a higher quality product with a saving in time, material and money.

Made from 52SO aluminum alloy of .035" gauge, the tubes are used to vent the fuel fumes from the wing tanks which Ryan builds for Boeing B-47 Stratojet bombers. The tube collects fumes at the forward end of the huge container and channels them rearward. It is located within the main strut fairing on top of the tank.

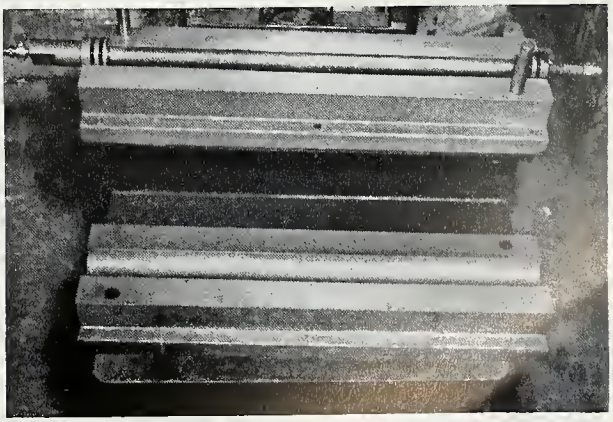
Because of the limited space within this streamlined fairing the vent tube must be quite irregular in contour. Its shape is circular in cross section in the mid-section and at both extremities. The other sections must be formed into elliptically-curved contours to squeeze into the available space. The carrying capacity of the tube must be maintained throughout its length and it must be smooth and gas-tight to perform its function.

At the beginning of the tank fabrication program, Ryan built these vent tubes from half stampings which

(Continued on Page 24)

Complex curves of Ryan fuel tank vent tube are studied by Edward Martin, tool engineer. Design involves both circular and elliptical sections with uniform cross-sectional area.

Ryan expansion die used to stretch tube sections prior to forming. Hydraulic fluid under pressure of 950 psi is pumped into tube through steel shaft shown in die.



AFTER— Neatly dangling from one of Ryan's new overhead conveyor lines, transition liners move into easy reach of employees.

PARTS ALOFT

BEFORE— Transition liners had to be moved about on top of "tote boxes" which took up large floor space and caused continual congestion.

WITH powered overhead conveyor systems, Ryan has telescoped production of two jet engine components into almost one third the space. Formerly occupying 9,000 square feet of factory floor area, jet engine combustion chambers and transition liners are now produced in a tidy 3,456 square feet.

Besides this impressive space-saving slash the new continuous conveyors have other important advantages. Parts handling time has been cut by two-thirds. The same production can be accomplished with 13 percent less manpower and parts quality is improved.

Used in General Electric J-47 jet power plants, the combustion chambers are cylindrical, perforated tanks which cage the blasting combustion of the engine. They must be carefully fabricated from one of industry's toughest, heat-defying alloys — Inconel.

Transition liners, also made of Inconel, are curved ducts which pipe the exploding gases from the combustion chambers into the turbine wheel arc. They are subjected to withering heat plus high pressure pulsations from the searing gases which course through them.

Methods men slash space by making cubic feet out of square feet

Both components are made in adjacent areas by similar methods. The formed sections are mated and spot-tacked together in exact alignment for this task. Ryan employs especially designed welding machines, which align and spotweld the assemblies in one operation. Then, the parts are permanently welded at their seams by resistance seam welding machines. Fittings and reinforcing members are welded on and the assemblies are rounded and sized in expanding mandrels. Finally, the completed components are inspected, marked and boxed for shipment. These requirements necessitate a good deal of parts handling and movement.

Before the conveyor systems were installed, the combustion chambers were transported in standard "tote" boxes which had to be rolled from one station to another. Transition liners, being smaller, were placed upon large flat tables on top of the "tote" boxes to bring them within reach of the employees. These parts handling devices occupied substantial amounts of floor space and required constant employee supervision.

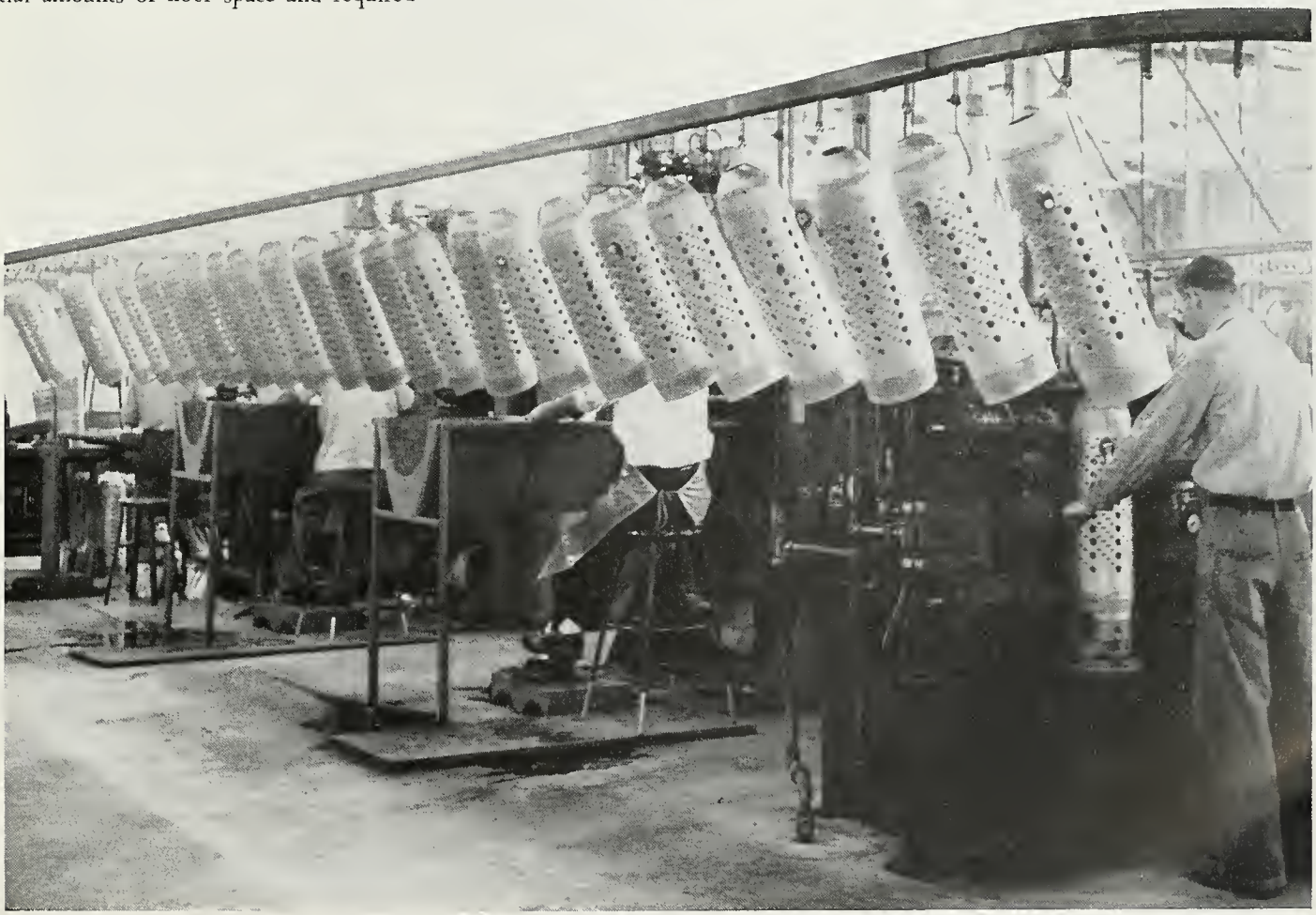
Ryan methods engineers Al Rider and Fred Sargent analyzed the project and developed a new production layout untilizing overhead conveyors. This technique has dual space-saving features. By bringing the parts to all employees in an unbroken, uniform flow, the bulky "tote" boxes have been eliminated and the machines more closely grouped together. By locating the conveyors overhead, a previously untapped source of space is pressed into service and valuable floor area is conserved.

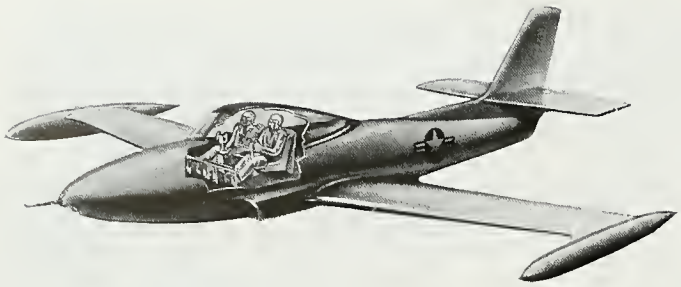
Designed by the Miller Crane and Conveyor Company of Los Angeles, the conveyors incorporate two continuous chains 165 feet and 124 feet in length. They roll on universally-coupled ball bearing assemblies which are spaced out at eight-inch intervals. Parts are carried on steel hooks which dangle from the chains. The entire system is suspended from the factory roof structure by steel supports.

(Continued on Page 27)

BEFORE— Combustion chambers form confusing array in system which took employees' time and energy.

AFTER— Raised conveyor keeps the parts in sequence, saves floor space and releases operator time.

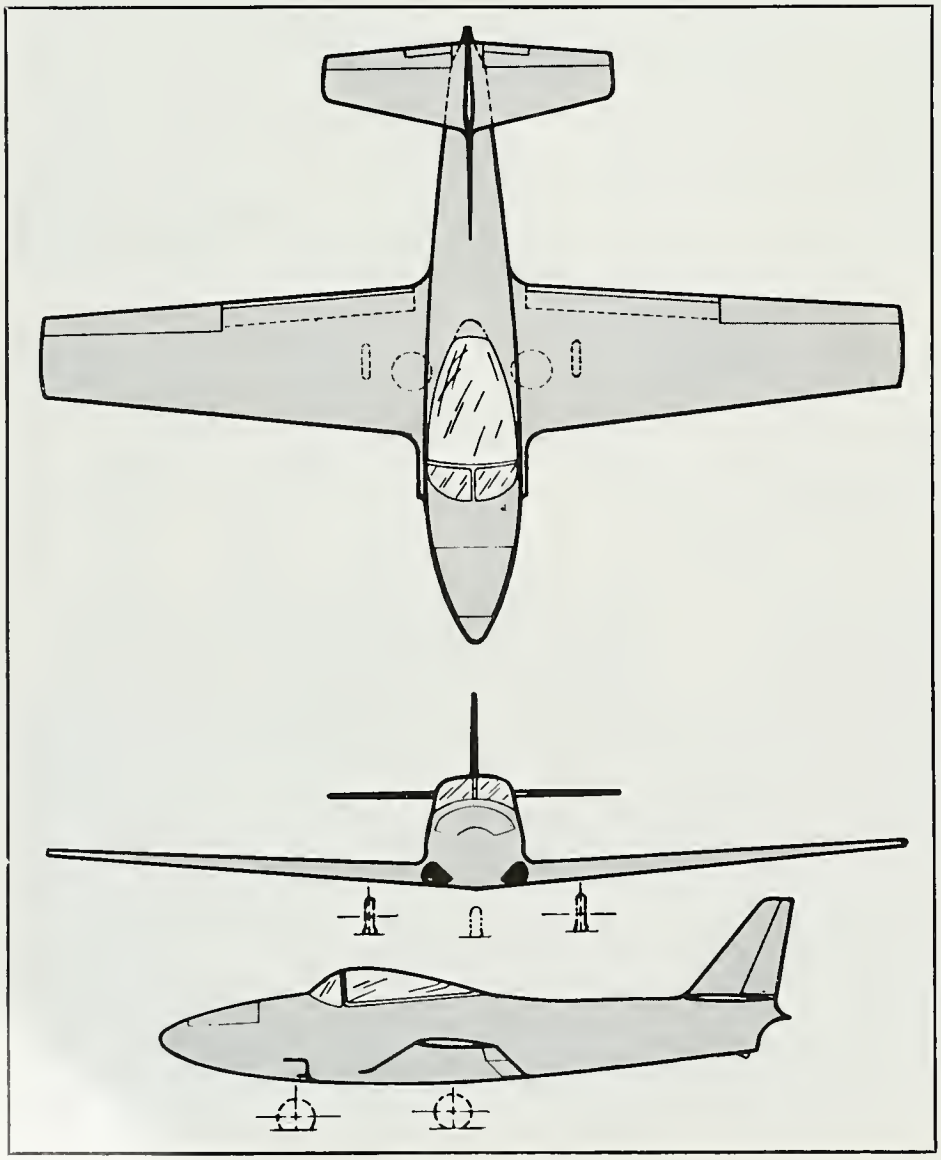




Ryan JET

The Ryan Primary Phase Trainer offers the military services an unusual opportunity, while the jet engine availability picture is still obscure, to conduct a test program in a single airframe with both the Allison engine and the dual Marbore installation, as well as with any other power plants which can be provided.

This overcomes the objection which has been raised to a foreign engine which must be Americanized and to a two-engine configuration; yet if the two Marbores should prove more adaptable than a single engine they can readily be used. The Ryan design avoids the danger of "putting all the eggs in one basket," and permits finalizing on the power plant after complete testing of all available engines.



FLEXIBILITY of design that permits interchange of power plants and versatility of function is the prime characteristic of Ryan Aeronautical Company's Model 59 Primary Phase Jet Trainer whose unusual features have attracted widespread interest.

Entered in a recent design competition conducted by the Air Force, the low-wing Model 59 monoplane possesses fundamental engineering concepts that have presented intriguing possibilities.

The major problem in the primary jet trainer field today is the uncertain power plant situation. No jet engine in the required power class has gone into quantity production; considerable testing and tooling lies ahead.

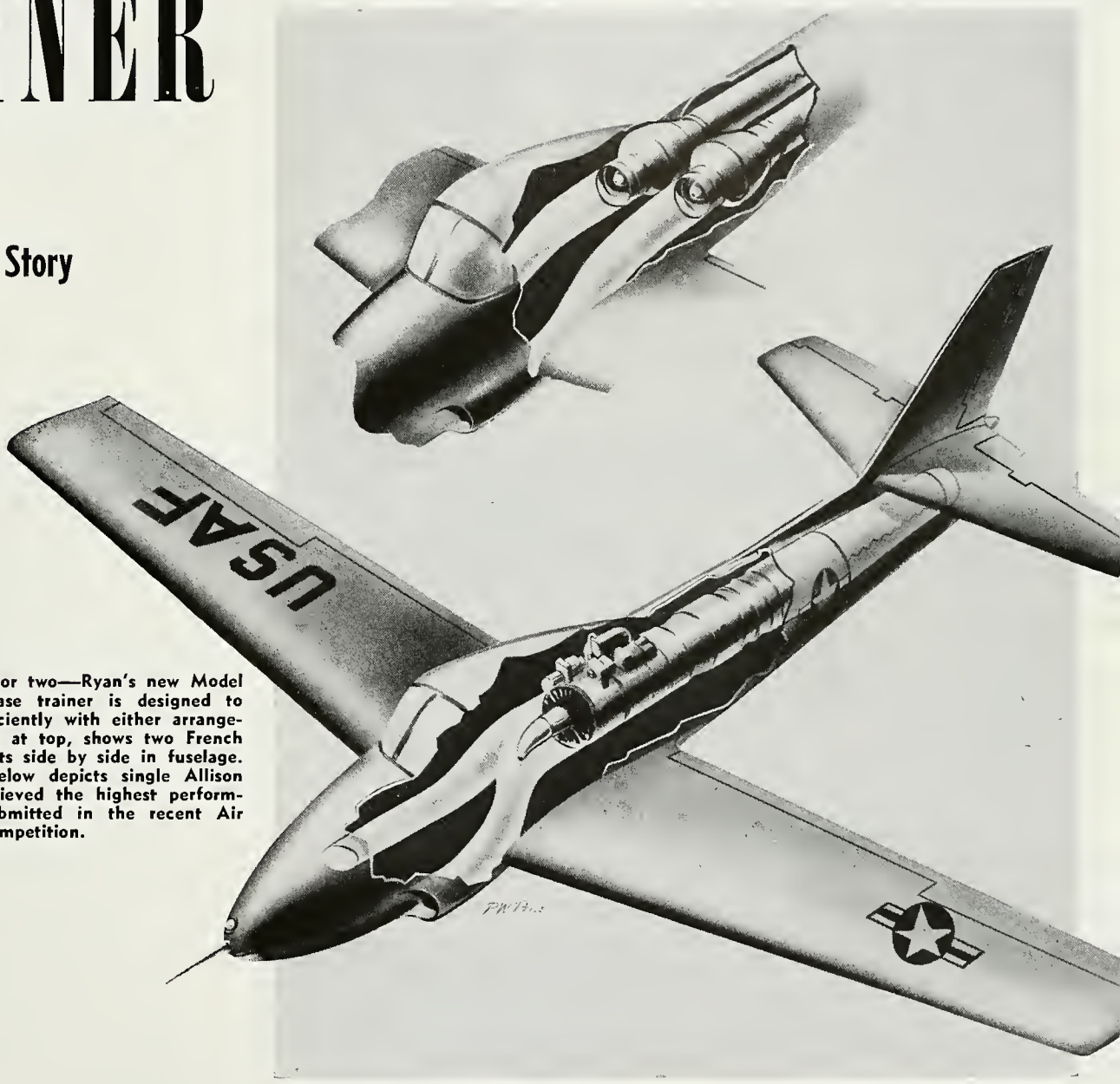
Faced with this reality, Ryan engineers wisely decided against committing themselves to a design for their jet trainer built around a single, specific power plant. Such a "frozen" design, they realized, would necessitate major changes to accommodate any other engine which might become more acceptable in the constantly changing jet engine picture.

Without committing the Air Force or other user to any particular engine Ryan engineers designed a jet trainer than can not only be built around any power plant that may be available in the near future, but can accommodate any engine of this power class that might be developed in the still more distant future.

Further, there is enough space in the fuselage of the Ryan trainer not only for a single engine, but enough volume has

TRAINER

Cover Story



One jet engine or two—Ryan's new Model 59 primary phase trainer is designed to function as efficiently with either arrangement. Cutaway, at top, shows two French Marbore 351 jets side by side in fuselage. Configuration below depicts single Allison 520-C1 jet, believed the highest performance design submitted in the recent Air Force trainer competition.

been provided for the installation of dual engines.

For design purposes two versions were submitted, one with a single Allison 520-C1 jet engine; the other with two French Marbore 351 jets.

The Model 59 with Allison engine, probably the highest performance design submitted in the Air Force competition, would have a maximum speed at sea level of 370 knots (427 mph), maximum speed at 35,000 feet of 379 knots (438 mph), and a cruising speed of 286 knots (329 mph) at 35,000 feet.

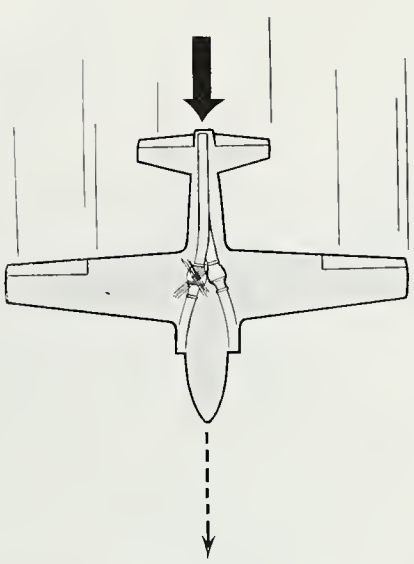
Initial rate of climb would be 4100 feet per minute. Its cruising ceiling would be 40,500 feet, service ceiling 42,700 feet. Takeoff distance over a 50-foot obstacle would be 1500 feet with flaps down, and landing distance over a 50-foot obstacle would be 2500 feet at full gross weight.

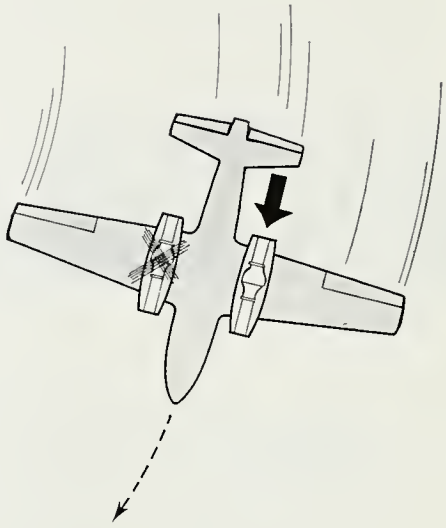
With the two Marbore engines, the Model 59 would have a cruising speed of 286 knots (329 mph) at 35,000 feet, and maximum speeds of 356 knots (410 mph) and 371 knots (428 mph) at sea level and 35,000 feet respectively.

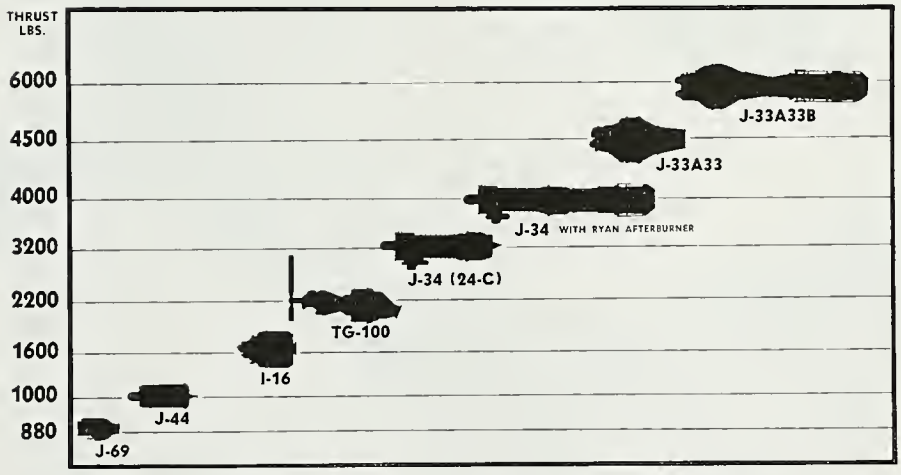
To extend the endurance, range, and utility of the plane, fixed wing tip tanks of 100 gallons each could be installed. The additional 200 gallons of fuel would extend the endurance from 2.9 hours to 5.16 hours at 35,000 feet with the Allison engine.

(Continued on next page)

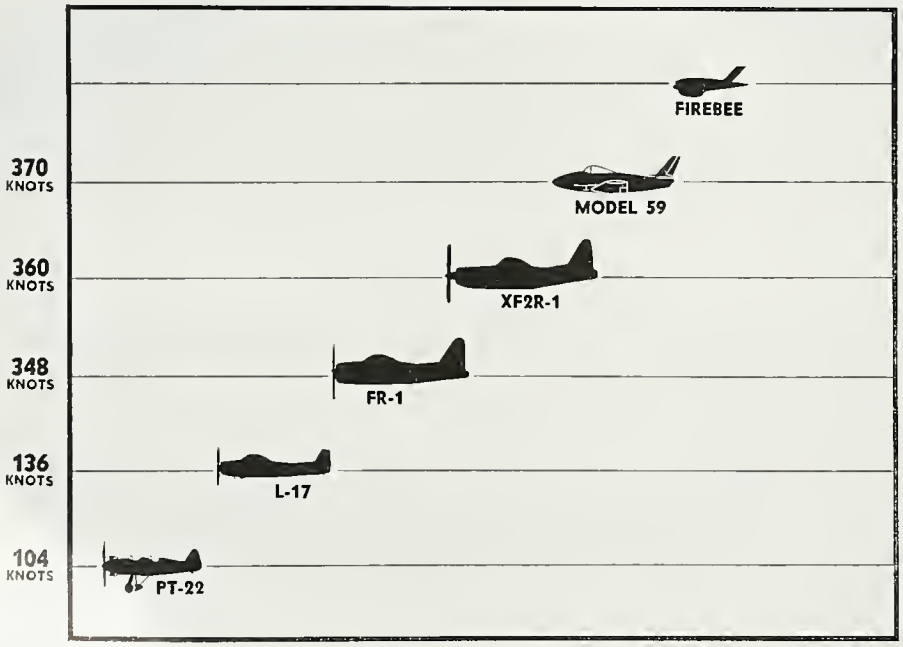
Yaw-free control with one engine dead is possible in Ryan two-engined Model 59 jet trainer, shown, left, in these drawings. Center of thrust remains down the center line of plane. In contrast, plane with jets in wing roots would tend to yaw.







Ryan Aeronautical Company's experience with airplane design and jet engine operation is graphically shown in the charts above and below. Planes' velocity has gone from 104 knots to "Firebee's" near-sonic speed (below), while jet thrust has increased from 800 to 6000 lbs. (above).



The Model 59 offers a hitherto untapped potential — the production of a primary trainer that could be adapted to prospective fighter AND bomber pilots. On the same assembly line, single engine and dual engine installations could be made, the single-engined aircraft to be employed by fighter trainees who would graduate to single-engined combat types, and the dual-engined planes to be utilized for more rapid adjustment of bomber trainees to multi-engined operation. The same basic trainer could be used for both, with no interrupting of production flow in the factory because either installation uses the same fuselage section.

The psychology, the needs and the aptitudes of the average student pilot were known and taken into consideration when the Model 59 design assumed shape. This human factor is extremely important in the new jet age, when training is complicated by the leap from the 250 mile per hour reciprocating engine plane in which the pilot learns the fundamentals of flight, to the 600 mile an hour jet combat plane — a gargantuan stride, with engine power increasing fourfold. Ryan engineers believe the two-place, side-by-side Model 59 — like the wartime Ryan PT low-wing trainer series, a revolutionary innovator in its field — admirably fills the gap.

An example of the effort to create a smooth, safe transition for the student pilot is the approach taken toward the possibility of failure of one engine in the dual-engine type trainer. In the Model 59 with the Marbore engines, twin engine safety would be achieved without adverse yaw effects such as might be expected in twin-engine planes when one engine fails. This can be accom-

plished because both engines in the Ryan trainer would be housed together in the fuselage, with the center of thrust down the center line of the plane.

In the conventional twin-engined arrangement, when an engine located in a wing root fails, the pilot must compensate for the inevitable yaw, complicating training in the primary phases. In the Model 59, with two Marbores, if one engine quit, there would simply be less thrust, but no trouble to the pilot from the standpoint of control. With one tailpipe located directly above the other in the aft fuselage, yaw would be no problem.

Each of the engines in the Model 59 dual engine arrangement receives air from one side entry duct, and exhaust is from the individual tailpipe. A butterfly valve in each entry duct, controlled from the cockpit, permits the closing of the entry when one engine is inoperative, thus reducing internal drag losses.

In the specified power class of the Air Force's projected primary phase trainer, two jet engines have reached the most advanced stage of development — the Allison Model 529-C1 and the French Turbomeca Marbore. The Allison is being prepared for production for the Navy; the Marbore is being converted to American standards for manufacture by Continental Aviation and Engineering Corp.

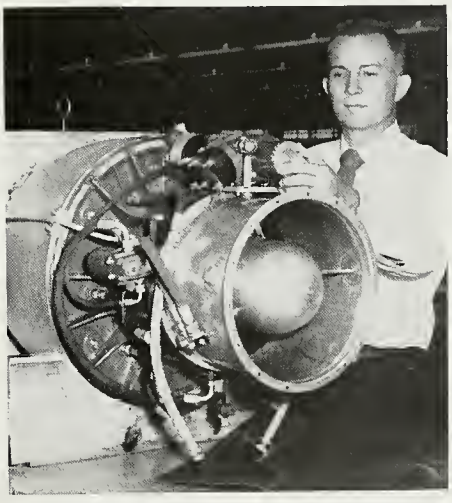
The Allison is a pure jet version of the T38 turboprop. It is rated at 1870 pounds thrust at sea level and has specific fuel consumption rate of .927 pounds per pound of thrust per hour. The Marbore is rated at 880 pounds thrust, with fuel consumption rate of 1.16 pounds.

The Ryan design provides for storage of all the fuel within the wing, reserving all the space to the rear of the cockpit for either one or two power plants. Sufficient room has been made available in the aft fuselage for any engine of a practical thrust range for this type plane. In effect, the flight "envelope" impose no limitations in that it is not inextricably linked with any particular engine. Thus, even after such a plane has gone into mass production, the assembly line need not be disrupted by a change in engines.

As the line continues in operation, alternate power plants could actually be installed with little effect on the production rate.

Thus, the Ryan design permits use of the same plane with either single or dual engines, depending on the requirements of the Air Force in its training program.

Ryan has had extensive experience with jet engines — more, as a matter of fact, than any other American firm with the French Marbore. The company's background of jet engine utilization completely spans both sides of the speed and power range of the Model 59. The Marbore engine has been extensively tested in the Ryan "Firebee" the sensational jet-propelled pilotless, remote controlled target plane which has been successfully flight tested for more than two years at the Holloman Air Development Center, Alamagordo, N. M.



Ryan has had experience with French Marbore jet engine in its "Firebee" target plane. Forrest Warren, Jr., project engineer, checks this foreign power plant.

Ryan also is unique in its experience with proven military planes containing two engines in the fuselage, instead of in the wing roots, to give yaw-free control with one engine inoperative. This was the trail-blazing FR-1 Fireball, the world's first jet-plus-propeller airplane and the Navy's first plane to use jet propulsion.

The front engine was a Wright Cyclone piston type, while in the aft fuselage, for extra bursts of speed, was a General Electric I-16 jet engine. The Fireball could operate on one or both engines. Its successor, the XF2R-1 Dark Shark, was an all-turbine Navy research plane with a G. E. TG-100 turbo-prop in the nose replacing the piston engine, and the I-16 in the aft fuselage. The Dark Shark was the first Navy plane to use a gas turbine turning a propeller.

Two other prop-jet engine combinations were used by Ryan. The XFR-4 had the Wright Cyclone in the nose and a Westinghouse 24-C jet aft. The XF2R-2, another model of the Dark Shark, was to have the 24-C jet equipped with Ryan afterburner, combining with the TG-100 turbo-prop. Ryan's current high-thrust jet engine operation is in classified research projects which cannot be further identified.

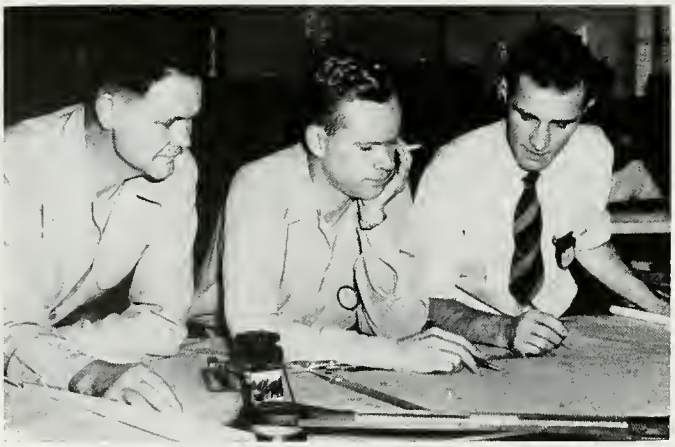
Thus, the Model 59 has capitalized on two major Ryan assets — practical experience in jet engine use dating back to the pioneering days of the early 1940s, and practical experience with two engines in one fuselage to attain yaw-free operation.

There was still another vast reservoir of experience on which the Ryan organization could draw — its fund of knowledge gained in the actual primary training of pilots for the Air Force.

During World War II, some 14,000 fledgling fliers earned their wings in Ryan schools operated for the Air Force in San Diego, Hemet, Cal., and Tucson, Ariz. They learned to fly in the famed Ryan PT series of primary trainers, low-

(Continued on Page 22)

Straight and tapered sections for Ryan external wing tanks—world's largest—are expand-formed under Ross Hernd's supervision.



Ryan tooling team who conceived the unique new technique and designed the machines to make it work are: (left to right) H. F. Wallen, C. C. Hasty and Richard Grabowsky. Three machines have been built and installed under direction of this trio.

EXPAND FORMIN

Ryan engineers magnify the expanding mandrel into a mammoth tool with a new mission in life

AN ingenious new expand forming technique for fabricating aluminum and stainless steel sheet metal parts has been developed by Ryan Aeronautical Company manufacturing engineers. Originally developed for production of the largest external wing fuel tanks ever designed, the new method has been so successful that it is being extended to the manufacture of large components for General Electric jet engines and other turbine power plants.

Principal role in the new forming process is played by the huge expanding mandrels which Ryan plant engineers have designed. Largest machine tool of its type in the world, Ryan's latest "heavyweight champion" can exert radial forces of 4800 tons—equivalent to the weight of a cruiser.

With the new technique which is relatively quite economical, Ryan is accomplishing the precision forming of large contoured closed sections to exact dimensions. The requirement for smooth contours and close tolerance is becoming increasingly important because of the advent of super-sonic jet-propelled aircraft. It is essential that the airfoil as calculated by the aerodynamicist become a reality on the actual aircraft. High speed planes demand contoured engine nacelles, wing tanks and other external appendages with the smoothest aerodynamic surfaces. Jet engines use substantial amounts of tubular structures of sheet metal and machined members which carry high precision requirements. And, the aircraft itself is rapidly taking on the configuration of a winged missile, with a circular cross-section and carefully tapered extremities.

The new Ryan expand forming process involves the fabrication of these contoured components by rolling the sheets into cone-shapes, which permits maximum forming with least elongation, and welding them with automatic heliarc welding machines. These fusion welds join the metal edges in a single-thickness bond of uninterrupted metal which is scarcely distinguishable from the sheet itself. Then the sections are placed over the segmented "shoes" of the expanding mandrel and stretched into shape and dimension with precise control.

The method is superior to conventional techniques of forming large contoured surfaces by hammer deformation or spin forming. It does not produce the warpage, typical of hammer forming, which causes "oil can" effect. It avoids thinning the metal, with resultant loss of strength, as sometimes occurs in spinning bell-shaped sections. It affords a reliable process by which parts can be con-

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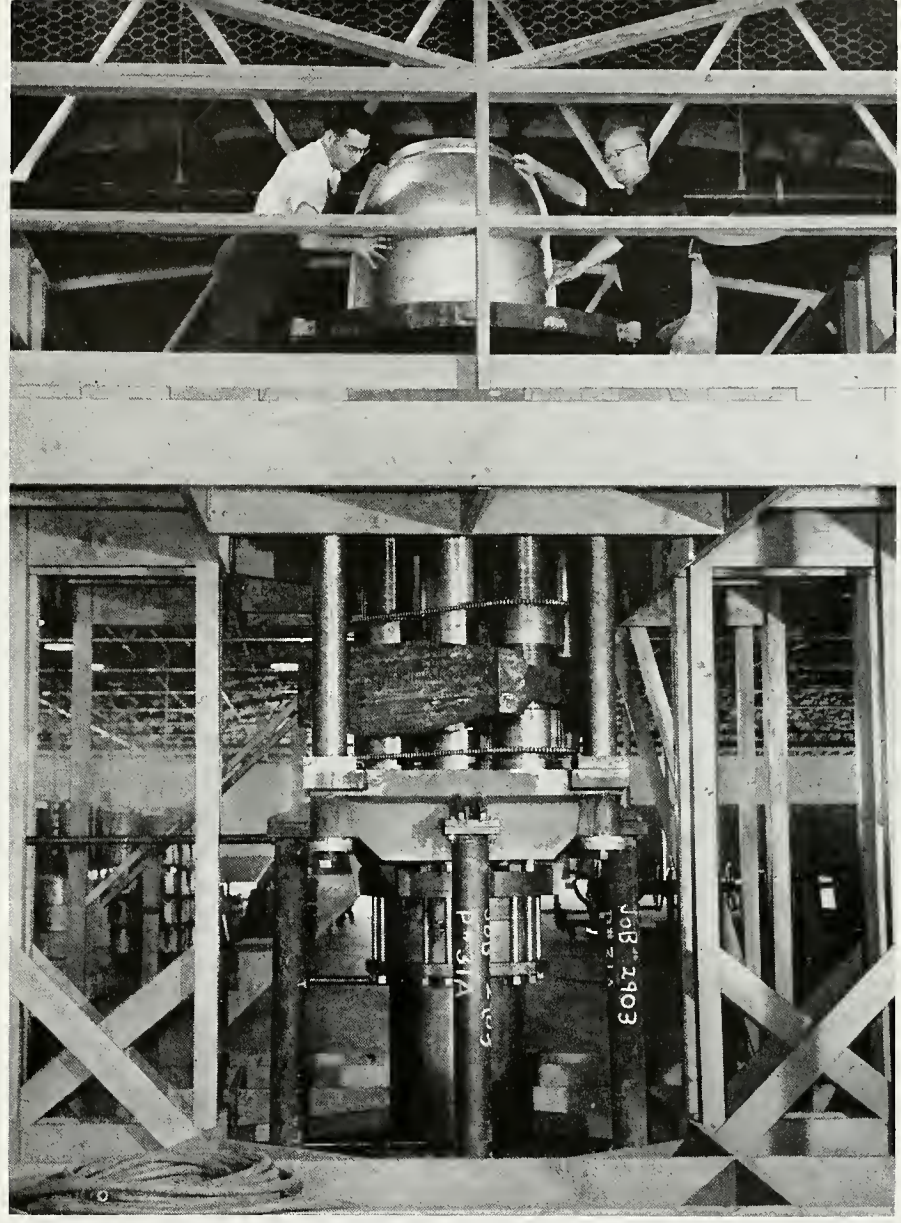
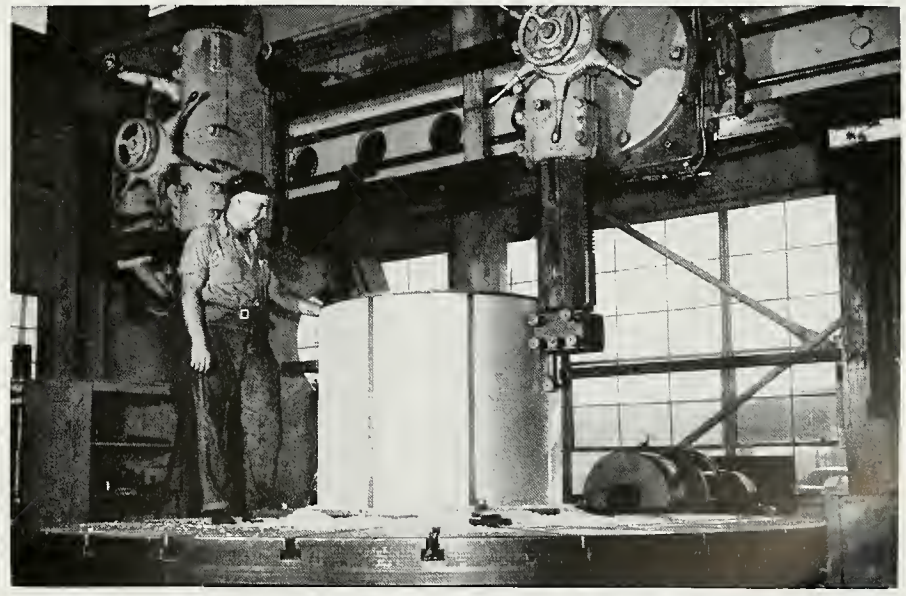
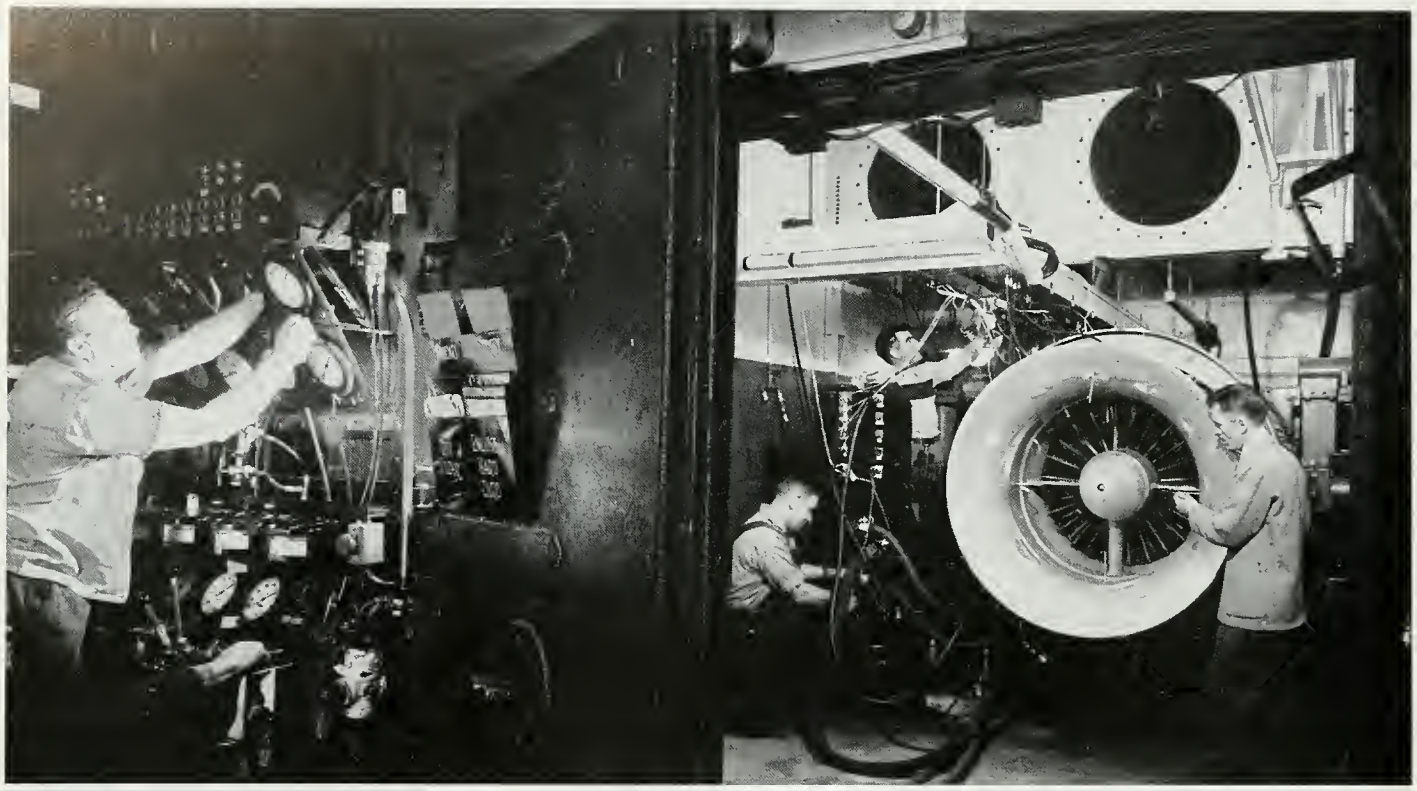


Prior to installation in pit, Ryan's big mandrel is pressed into service to put a 4800-ton squeeze on afterburner nozzles. E. W. Bell and L. Hefte adjust the part.



Segmented forming shoes are accurately machined on vertical turret lathe. Salient feature of mandrel technique is use of relatively economical aluminum alloy dies.



Ready to roar into action, a powerful new jet engine is prepared for earthbound "flight" in General Electric Company's test cell.

From the coldly scientific laboratory come new metals for firing shrieking demons through space

JET

First to crash the sound barrier, the Bell X-1 fires its rocket motor which weighs 200 lbs. and can exert 20,000 equivalent h.p.

NOTHING has ever put the heat on metals like the jet engine. This era has already been labeled the "high temperature age" because of the impact which this swirling inferno has exerted upon modern life. It is consuming undreamed of tons of hard-to-get alloys at an alarming tempo. Yet, in the metallurgist's mad scramble to feed its fires, the jet power plant provides a mighty incentive which is uncovering a wealth of knowledge about new metals and their unpredictable combinations.

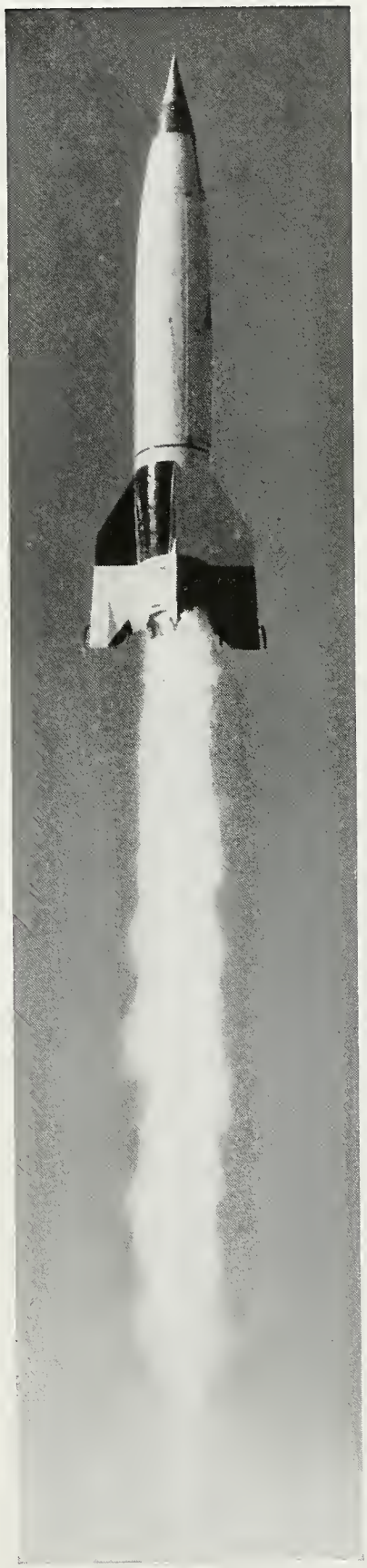
From the birth of the universe until the 16th century, only seven metals were known and used by man: gold, silver, copper, tin, iron, lead and mercury. These were found freest in nature. During the next three centuries, seven more metals were discovered. But in the last fifty years, scientists have unearthed 69 additional metals to bring the total to 83, or more than three fourths of the 100 elements known to exist. Now, the searchlight of science is being turned on the one third of these metallic elements

METALS

which have been little more than laboratory curiosities.

Impetus for this metallurgical research is the pressing need for materials which can defy the consuming heat of shimmering jet engines, some of which can blaze away 2,000 gallons of fuel an hour. The Ryan Aeronautical Company is prominent in this quest because Ryan is an important producer of the "hot end" components of the nation's jet power plants. Rapidly becoming as familiar as the pistons and cylinders of the conventional engine, "hot end" parts are combustion chambers, exhaust cones and afterburners of the jet engine.

For sixteen years Ryan has designed and built welded stainless steel exhaust systems for piston engines and thus gleaned a backlog of know-how in handling heat resistant alloys in sheet form. The sudden emergence of the jet engine posed terrific problems in many fields of production because it is radically different from the piston type power plant which is largely tailored from forgings and castings. But because the jet family of engines encompasses substantial proportions of high temperature sheet metal structures, Ryan facilities and experience are particularly well suited to this new heat engine.



Outward bound, the fearsome V-2 trails a cometlike tail of flame. In one minute it consumes 9 tons of fuel and rockets to 3500 mph.

With jet planes flying at supersonic speeds above 50,000 feet in routine flights, the turbojet is already five times as powerful as the largest piston engine-propeller drive and its installed weight is less than one quarter that of a piston engine of comparable power at high speed. Yet engineers declare that the potential of this infant prodigy has scarcely been tapped. Compact engines with power equivalent to 30,000 horsepower are envisaged if temperatures and pressures can be increased. And that is where the metallurgist is pacing performance. New materials with prescribed high temperature properties must be synthesized to meet the challenge.

What are the temperatures encountered in the jet engine? Highest readings are found in combustion chambers and afterburners where flame temperatures soaring to 3700°F. have been tallied. Since this is 1000 degrees hotter than the melting point of the alloys used in these structures it is evident that wall temperatures are considerably lower than these figures. Actually the metals operate at temperatures within the range of 1200° to 1800°F. This disparity between flame and wall temperatures is accomplished by ingenious design innovations which insure the centering of the combustion flames within the structures and provide a blanket of cooling air around each component.

Why are metallurgists facing a dilemma in finding alloys to withstand operating temperatures of 2000°F. when a number of metals have melting points greatly in excess of this figure? For instance tungsten melts at 6200°F., molybdenum at 4800°F. and columbium at 4400°F. But melting point is not the important consideration in determining whether a metal can withstand the rigors of jet engine environment.

The three characteristics which metallurgists search for in the heredity of a well-bred metal for high temperature application are oxidation resistance, high temperature strength and corrosion resistance. Probably the most vital of these is capacity to resist oxidation because structural strength is useless if a metal rapidly burns away. At jet engine operating temperatures, ordinary steel burns like paper, and tungsten, molybdenum and columbium oxidize quickly as do most high melting point metals.

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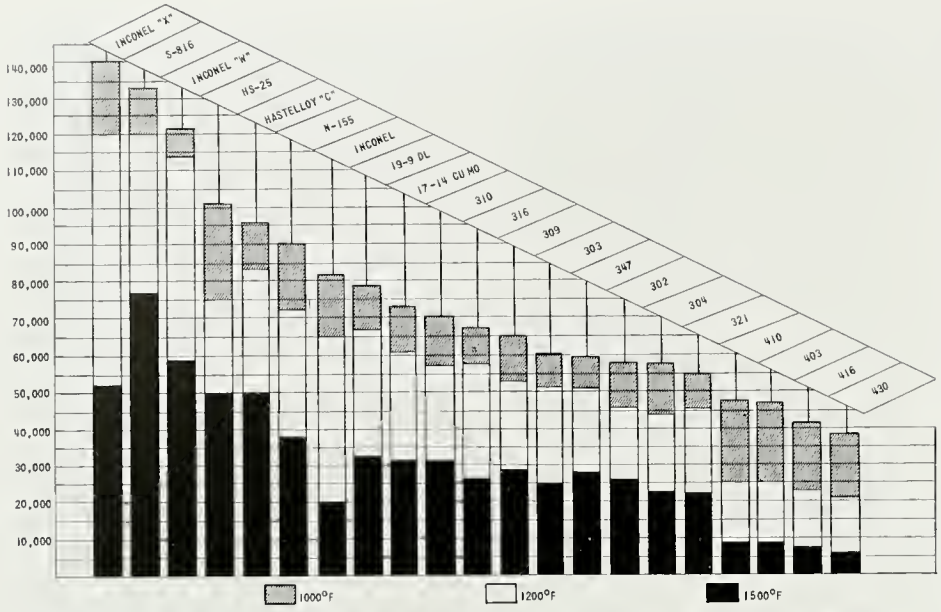
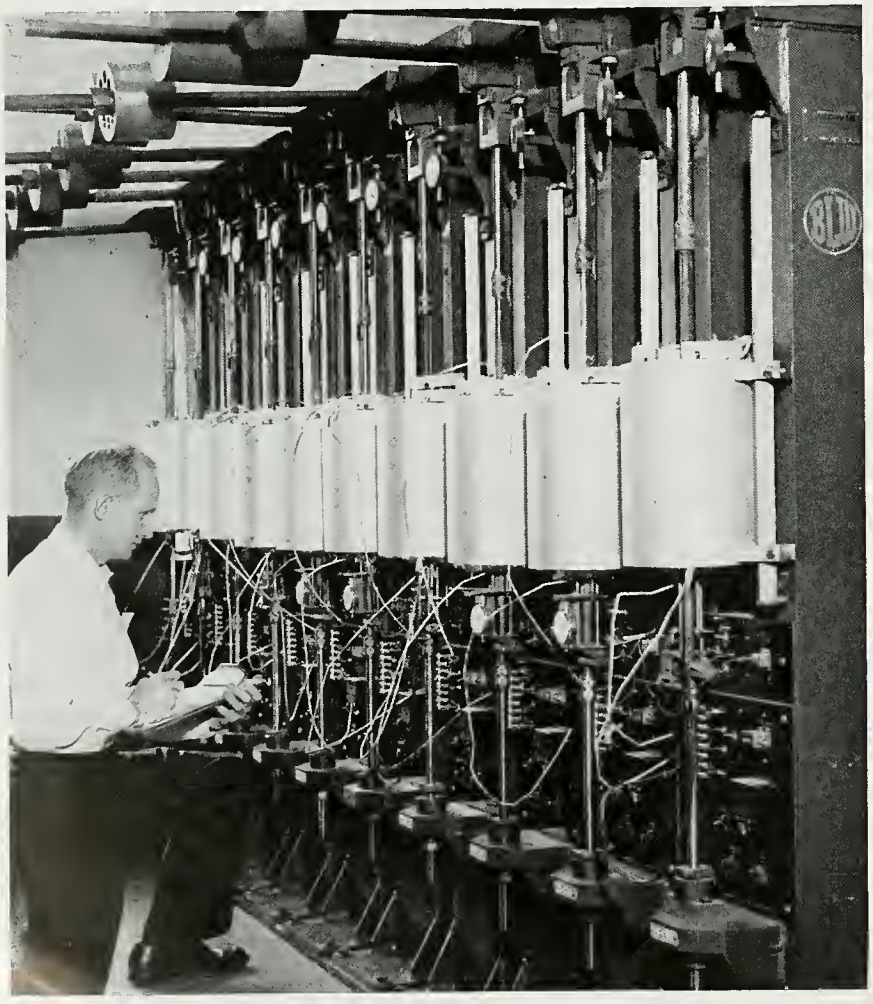


Ryan chart showing comparative Ultimate Tensile Strengths of jet metals under three varied temperatures, expressed in psi. and based on mean test averages.



Creep test set-up at International Nickel Company. Designed to find out how much heat and load a metal can sustain over a long period without stretching more than one tenth of one percent, creep test data is vital to jet research.

OXIDATION RESISTANCE

ABILITY of a metal to resist oxidation at elevated temperatures is largely determined by the type of oxide scale it forms. Laboratory investigations show that many metals form a tough, impervious scale which retards progressive oxidation. Others form a porous type of scale which continues to build up and flake away, eating into the metal. However, over prolonged periods of exposure, almost every type of oxide film tends to break down due to compressive stresses which are set up. The effects of repetitive heating and cooling cycles, experienced in jet engine operation, cause compressive stresses in the oxide film because the underlying metal tends to contract faster than the oxide scale. Alloys having high coefficients of thermal expansion aggravate this condition because they exhibit greater dimensional change under varying temperature.

HIGH TEMPERATURE STRENGTH

THE second vital quality which a metal must possess for jet engine use is good strength at high temperatures. This involves all kinds of strength exhibited stress rupture strength. There is a striking by alloys such as ultimate tensile strength, yield tensile strength, creep strength and difference in the behavior of metals at room temperature and the torrid environment experienced in jet power plants. A good conception of this can be obtained when it is realized that structural carbon steel, with a room temperature strength of 140,000 p.s.i., would have an ultimate tensile strength of only 1,000 p.s.i. after exposure to 1400°F. for 1,000 hours.

The design of load-bearing structures for service at atmospheric temperatures is generally based upon yield or tensile strength which is determined in ordinary room temperature tensile tests. In service at ordinary temperatures, with a design stress determined in this way, a metal behaves essentially in an elastic manner. The structure undergoes an elastic deformation immediately upon application of the load and no further deformation occurs with time. When the load is removed, the structure returns to its original dimensions.

At elevated temperatures the behavior is quite different. A structure will continue to deform with time after load application even though the design data may have been based upon tensile tests taken at the elevated temperature. This is due to the fact that tensile tests are relatively short term affairs, accomplished within a few minutes. Under prolonged application of temperature and stress,

metals tend to deform at a slow rate. This deformation is called "creep" and is expressed in terms of pounds per square inch required to produce an elongation of one percent in 10,000 hours of exposure at the specified temperature. For jet engine parts, where precision and exact dimension are a necessity, high creep strength is of prime importance. Certain rotating structural members must have a creep strength which will resist a one percent elongation in 100,000 hours of service—about 11 years.

Creep of a metal under constant load and temperature occurs in three stages. First, the metal elongates rapidly but at a decreasing rate. In the second stage, usually of longer duration, the rate becomes constant. Third stage occurs when the elongation rate increases rapidly until the metal fails.

At the beginning of a creep strength test the metal will exhibit an elastic extension before it starts to flow. Also, if the test is not carried to fracture, the metal will contract a similar amount when the load is removed. From these phenomena it is apparent that metals creeping under stress at high temperature possess both elastic and plastic properties simultaneously.

A metal will not stretch indefinitely without fracturing. Therefore it is important to the designer of high temperature components to know when a metal will rupture under conditions which produce creep. Since creep tests are usually long term undertakings (some have been run for ten years), another means has been evolved to disclose the stress rupture point of metals. Similar to the creep test, this test utilizes a greater strain than the creep test in order to speed up the elongation process. By extrapolation of creep and stress rupture test data it is possible to determine when a metal will fail under prescribed conditions. This failure occurs at lower stresses than the ultimate tensile strength of the material.

CORROSION RESISTANCE

THE third characteristic which catches the eye of the high temperature metallurgist is corrosion resistance. Corrosion is the destructive alteration of a solid body by chemical or electrochemical reactions arising on the surface. Usually metals are corroded by chemical solutions in which some of the positively charged ions in the solution lose electrical charges to the metal being corroded. The elevated temperatures concomitant with jet engine performance amplify and accelerate the factors causing corrosion, which are products of combustion and atmospheric elements.

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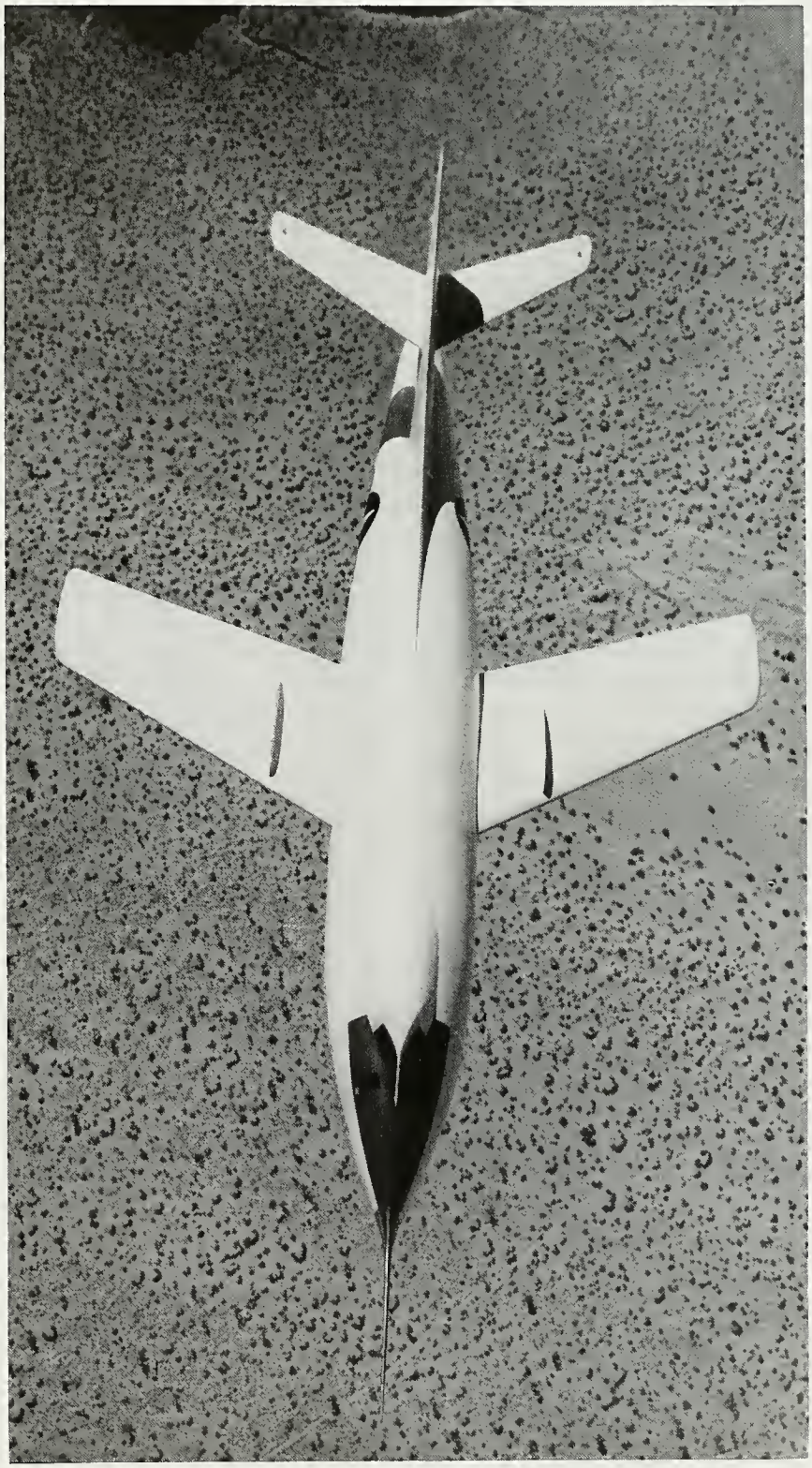
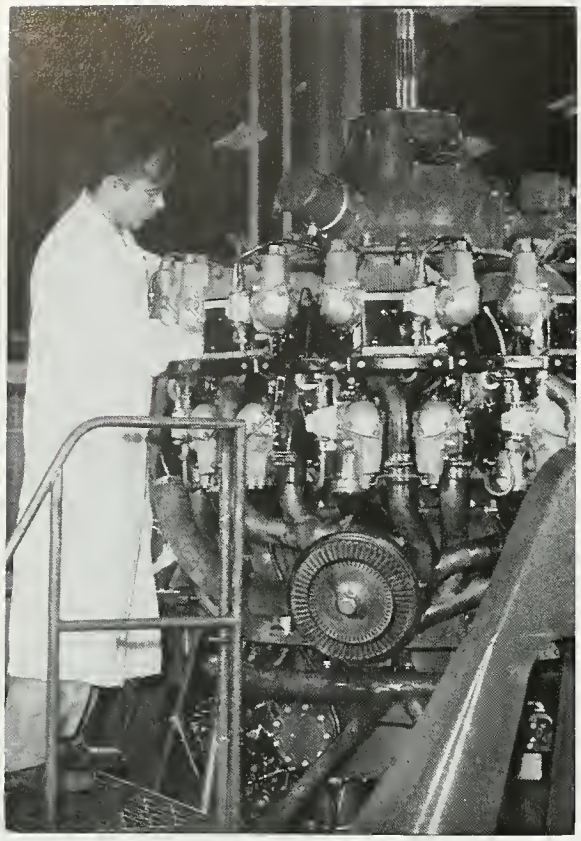


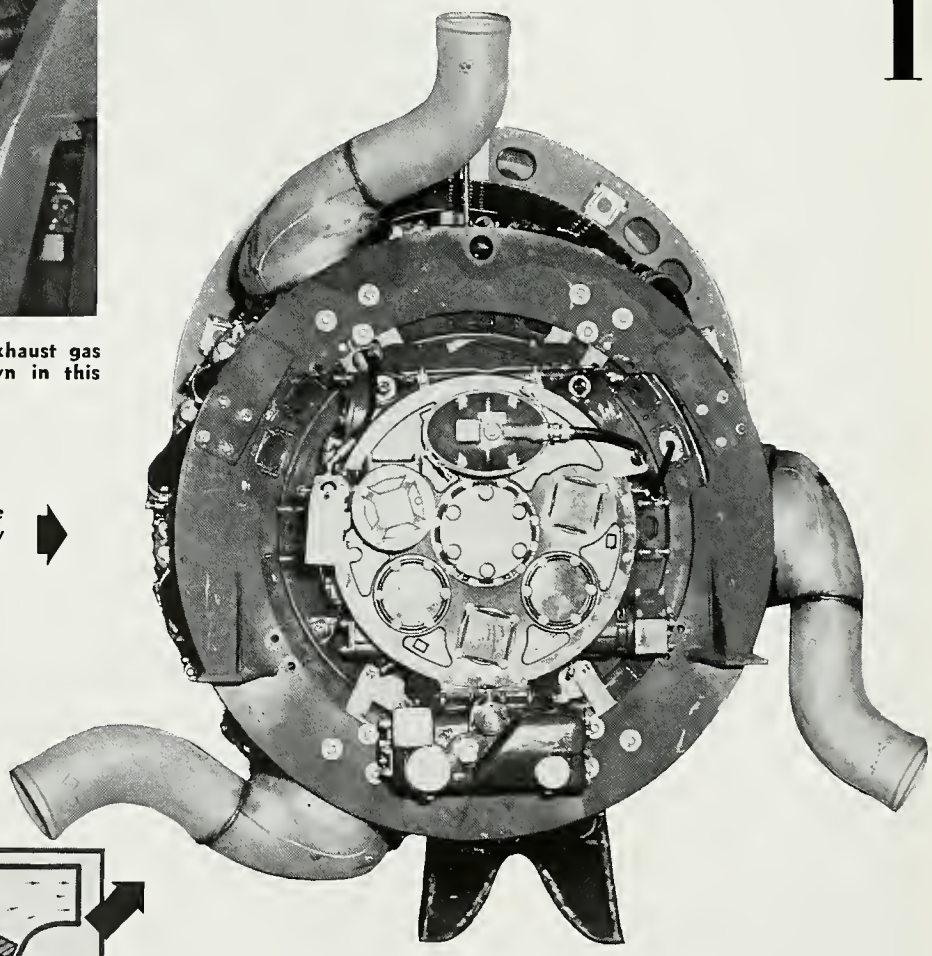
World's fastest aircraft, the supersonic Douglas Skyrocket has probably ticked off 1500 mph. under the cool control of Bill Bridgeman, Douglas pilot. Mostly fuselage, with vestigial wings, the Skyrocket is a 15,000 lb. winged bullet.



Power recovery system in which supersonic exhaust gas is harnessed to spin geared turbines is shown in this Turbo-cyclone engine in the Wright plant.

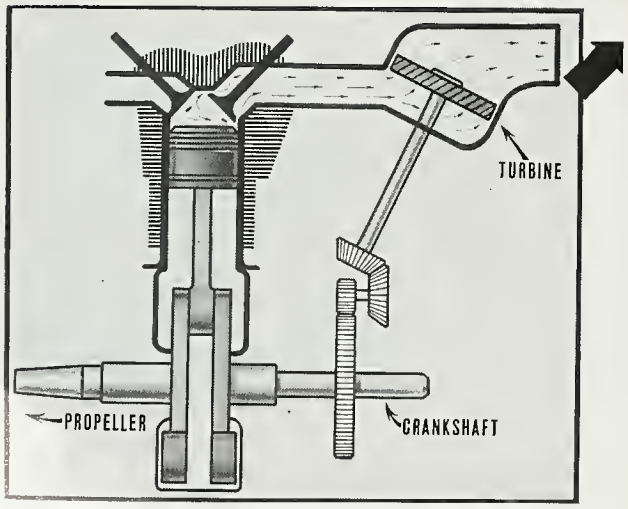
Fairchild C-119F "Flying Boxcar" is largest user of compound power plants and ultimate destination of Ryan turbine hoods.

TU



Resembling a Fourth of July pin wheel, the Ryan turbine hoods stand out in this end view of a Wright R-3350 compound engine.

How Wright engineers have merged piston and turbine power plants by compounding is depicted in this schematic drawing.



Wright compounding pays a twenty percent power dividend

RBINE HOODS

RYAN is building thousands of high temperature components which airframe manufacturers install on the new Wright R-3350 turbo-compound aircraft engines. Rated as the piston engine which develops maximum power — per pound of weight — per cubic inch of displacement — per pound of fuel consumed — the R-3350 is being installed in Fairchild C-119F "Flying Boxcars," Lockheed Super Constellations and is slated for the new Douglas DC-7 luxury airliner.

With an ingenious technique, called "compounding," Wright engineers have stepped up the power of this 18-cylinder engine by twenty percent to a whopping 3500-plus horsepower. This amazing increase has been accomplished without the combustion of a single added drop of gasoline or use of additional operating controls. The extra power can be translated into a twenty percent increase in aircraft range with the same amount of fuel or a fifty percent increase in payload capacity.

The premium horsepower has been gleaned from the heat energy, formerly wasted, in the exhaust gases escaping from the cylinders. The temperature of this searing gas runs as high as 1500°F. and its velocity is greater than the speed of sound. Wright engineers harnessed this furious blast to drive three power recovery gas turbines which are geared to the engine's crankshaft. In this way, the twenty percent boost in power is transmitted to the propeller drive.

Ryan fabricates the exhaust hoods which collect the hot gases as they ricochet off the whirling turbine blades. These hoods channel the exhaust to an outlet which extends through the engine nacelle and into the air stream. Ryan is also performing work on cooling caps which are used to collect cooling air after it passes through the turbine wheel and eject it into the exhaust stream within the turbine hood.

The turbine exhaust hoods are made of type 19-9DL stainless steel, a particularly strong and oxidation-resistant alloy at elevated temperatures. Use of this metal is an extra Ryan design precaution dictated by the possibility of afterburning occurring within the hood. At certain fuel-air mixtures, it is possible to obtain a condition where the unburned fuel in the turbine exhaust and the oxygen in the cooling air will ignite at the point where these gas streams merge. Fortunately, the attendant gas temperature rise encountered with this phenomenon does not cause a similar duct wall increase in temperature because of the cooling effects of the atmosphere.

Ryan ships the completed exhaust hoods to both Fairchild Engine and Airplane Corporation at Hagerstown, Maryland and Kaiser Manufacturing Corporation at Willow Run, Michigan. In these plants the hoods are installed in the Fairchild C-119F Packets which are powered by Wright R-3350 engines. Ryan also built the huge external fuel tanks for the Fairchild C-119H, recently announced as the latest model in the famous "Flying Boxcar" series of troop and cargo carrying transports.

The turbine hoods are dome-shaped in design with a cylindrical outlet section projecting from one side. A machined flange is inserted in the large opening to form a smooth mating surface for attachment to the turbine nozzle box. At-

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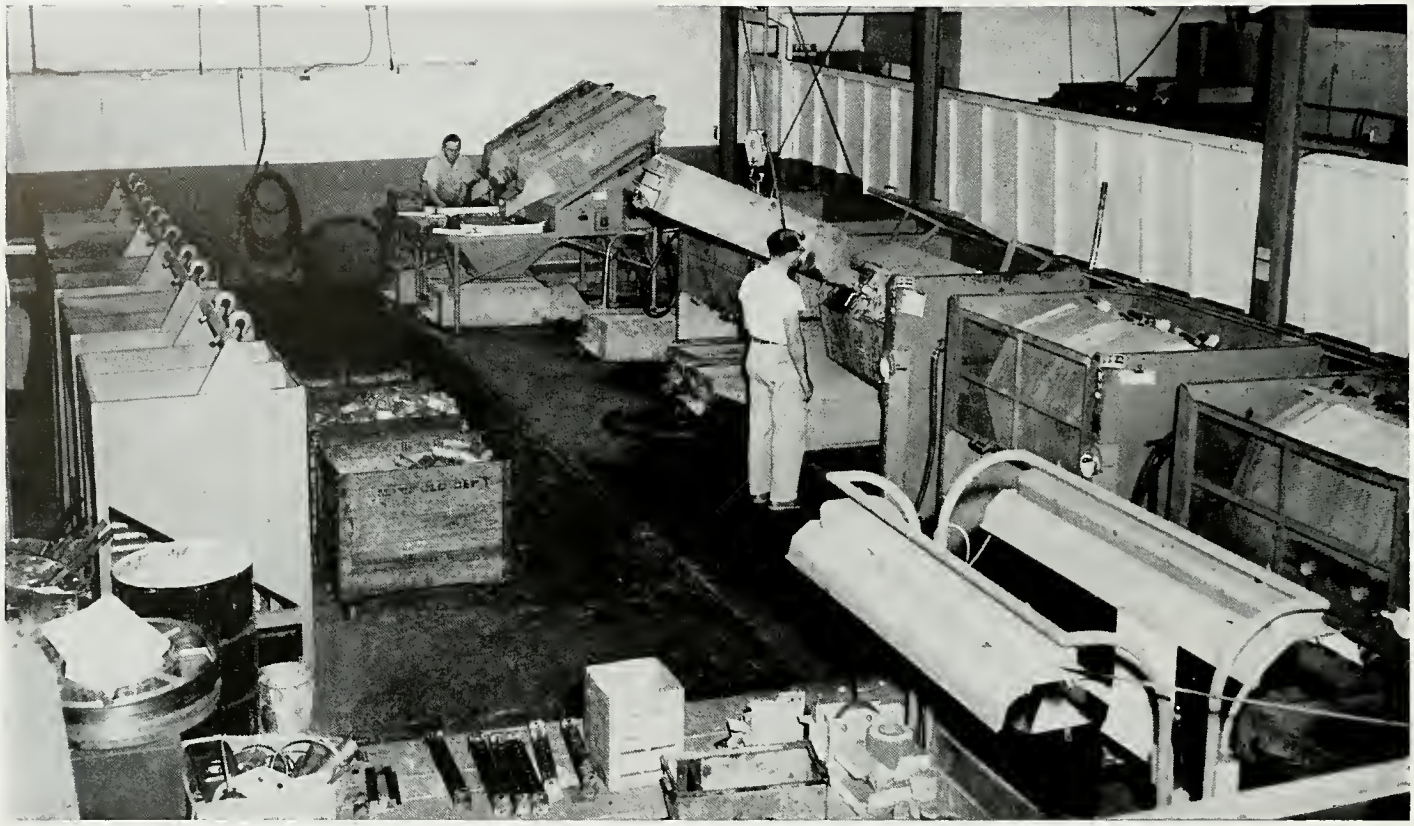
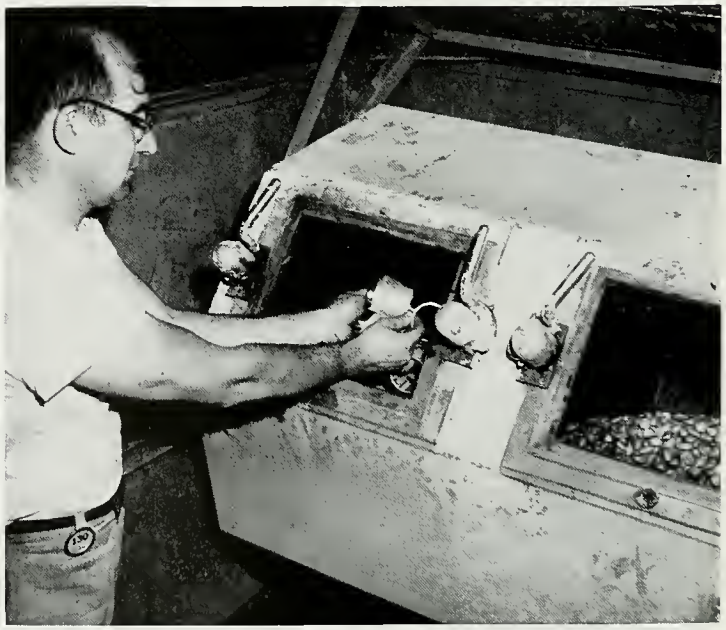
Made of 19-9DL stainless steel, Ryan turbine hoods are assembled to machined flanges in precision fixtures prior to spot welding.



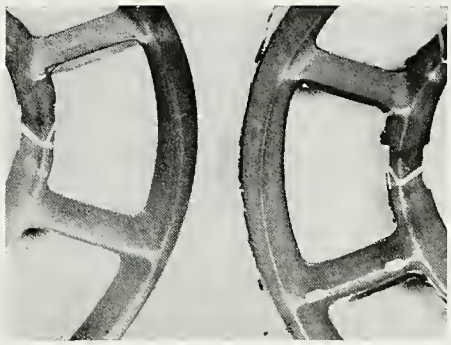
Metal parts are "laundered" by this battery of giant Roto-Finish "tumbling" machines which are saving Ryan up to $100,000 a year.

MACHINE SHOP "LAUNDRY"

1. By means of an overhead crane, the grinding chips are loaded into opening of the "tumbling" machine.



2. Parts to be finished are inserted into cylinder by William Kumpf, Roto-Finish operator. Note grinding chips at right.



Before and after deburring in "tumbling" machines—note smooth edges and glossy finish of component for Westinghouse jet engine afterburner, left, in contrast with similar unfinished section at right.

IT has the appearance of a self-service laundry, smack in the middle of the machine shop of the main factory building.

Octagonal cylinders revolving, water and detergent compounds poured in periodically, a gently cascading action inside the whirling containers . . .

In a sense, this portion of the Ryan Aeronautical Company plant actually is a laundry—a metal laundry, in which rough, stained metal parts are given smooth edges and a bright glaze.

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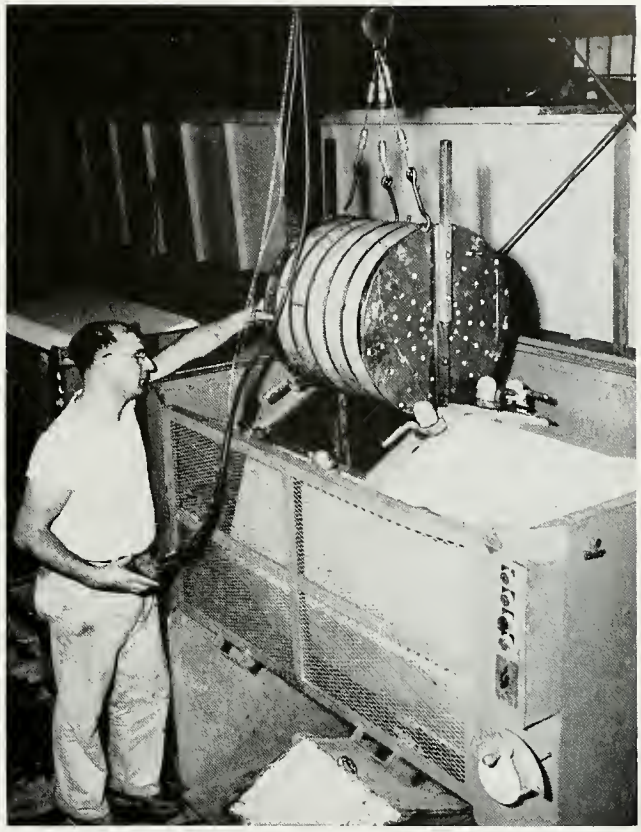
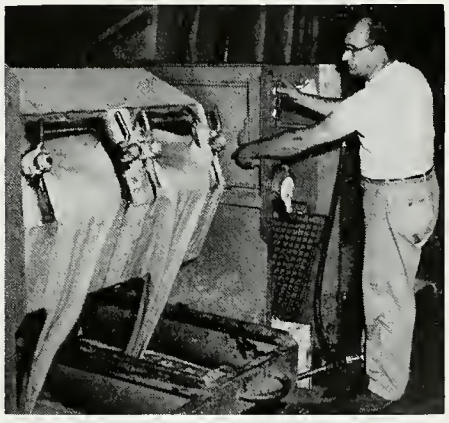


3. Larger parts, which cannot be "free-tumbled," are clamped into fixture and lowered into the machine.



4. Detergent is poured out of machine after deburring large number of parts.

5. After parts and grinding chips are removed from "tumbling" machines, they are separated in this mechanical device.

Revolving cylinders cut projecting edges and production time

RYNALLOY—a Metal is BORN

Jack Lucast, of Ryan, points to the Rynalloy ball-and-socket exhaust system used on Douglas Globemaster II power plants.

RYAN has created a new alloy to cope with the extreme temperatures encountered in aircraft exhaust systems. Christened "Rynalloy," the new metal has been given prescribed properties by the Ryan development laboratories, which are superior to those of any alloy suitable for the application.

Rynalloy is a heat and corrosion resistant cast alloy designed for service at temperatures up to 1800°F. with Ryan ball-and-socket joints. An exclusive patented Ryan device, ball-and-socket joints are the most successful means for imparting complete flexibility to aircraft exhaust systems. More than two-and-a-half million of these universal action joints have been incorporated into the exhaust systems of the nation's large commercial and military aircraft.

Fabricated in a variety of sizes from one-and-one-quarter to five inches in diameter, ball and socket joints consist of three parts. The "ball" is actually a spherical section with a cylindrical bore through it. It is retained in a stainless steel tube which has been flared into a close-fitting cup at one end. Within the ball, another tube is inserted and flared to form

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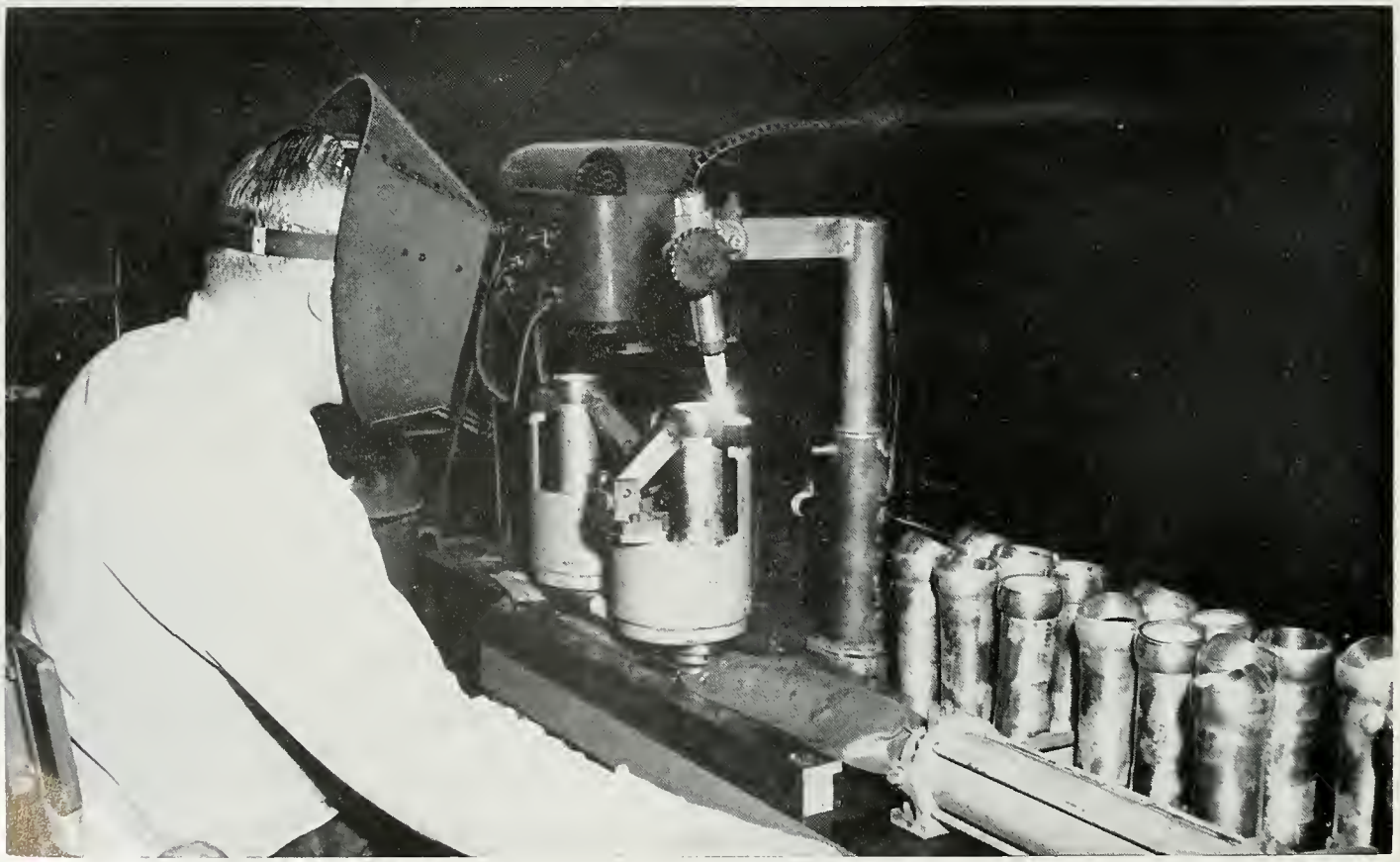
Fast Heliarc welder and Ryan-designed revolving fixtures are used to attach Rynalloy balls to stainless steel tubes in few seconds.



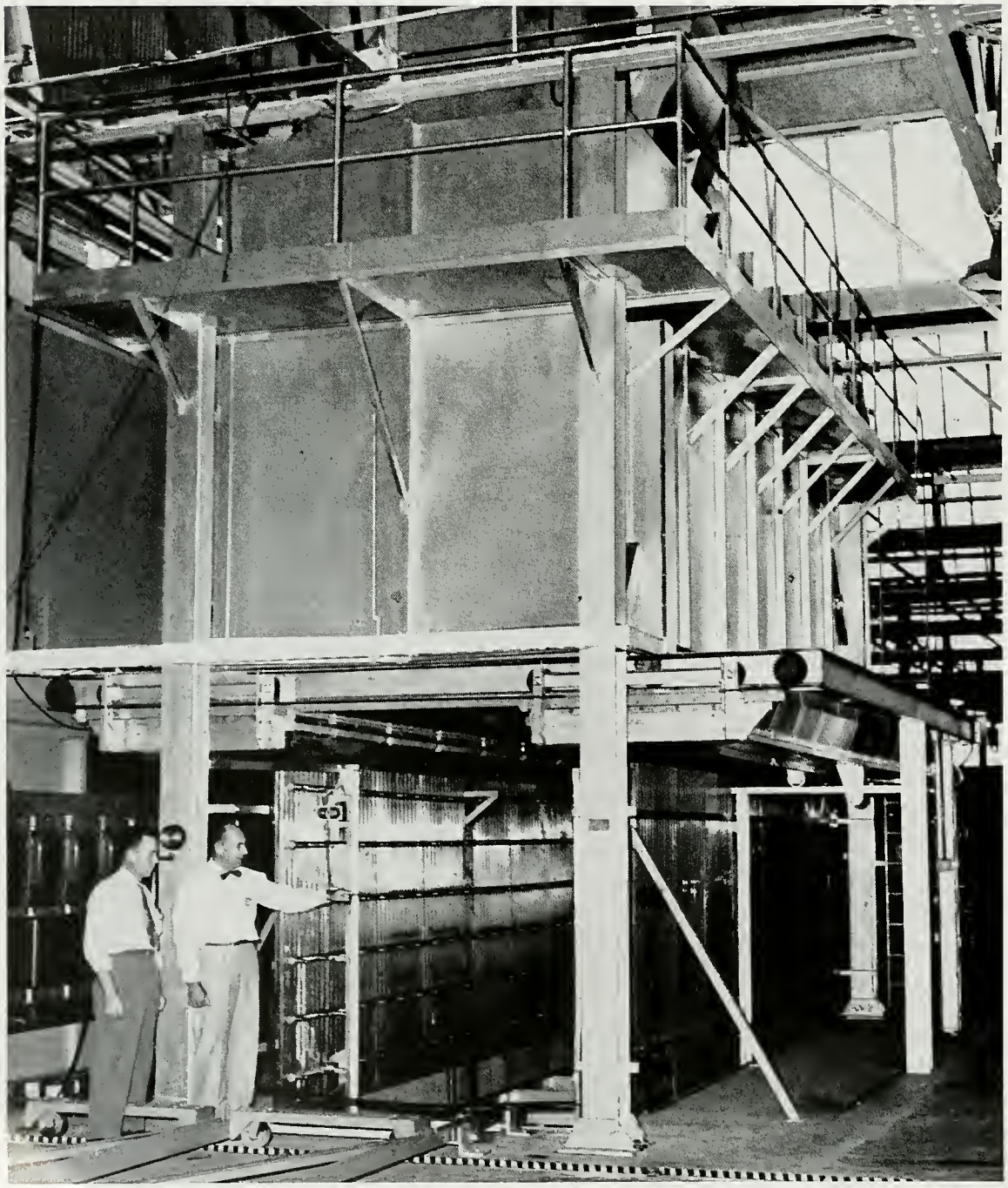
Dave Adams, Ryan metallurgist, removes crucible of molten metal from a 2300-degree electric furnace in typical research project.

A unique alloy with special properties is tailored to meet a tough new assignment

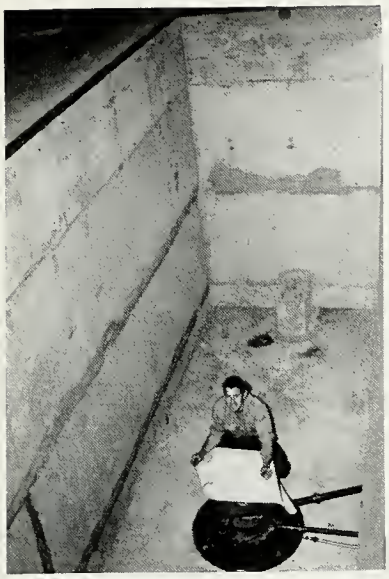
Exceptional properties of Rynalloy are demonstrated in this view of a Rynalloy ball (right) and competitive alloy (left) which have been exposed to 1650°F. for 100 hours.

QUICK-

Ryan's fast new furnace puts hot parts under a cold shower



Just installed, the imposing Knapp furnace towers over plant engineers Emil Orlando and Herbert Sadd who worked on its installation. Sadd points to the spray bar enclosure which dashes cold water on hot parts.



Eleven feet down in the water pit under the big furnace, Bob Kocher checks progress on a blueprint.

the heat treatment. For instance, 24S regains 90 percent of its strength and hardness within 24 hours after heat treatment. It picks up 90 percent of the remaining 10 percent within the following 72 hours.

Obviously, if the metals were completely heat treated at the mill they would age harden before being received at Ryan and would be too hard for severe forming requirements. Therefore, Ryan heat treats them in the plant and either forms them at once or places them under refrigeration until they are to be formed.

By bringing the aluminum alloy up to specified temperatures which are close to 1000°F. it is possible to produce a condition of "solid solution" in which all of the copper in the metal is dissolved without melting the metal. When this occurs the alloy is very ductile.

If the metal is allowed to cool gradually, the copper will precipitate out of solution to form an undesirable precipitate consisting of large particles which substantially reduce the strength of the material. On the other hand, if the metal is suddenly cooled to room temperature, within a few seconds, the copper remains in solid solution. When age hardened the precipitate is uniformly distributed in extremely minute particles between crystals where it can exert maximum keying effect.

By placing the quick-cooled parts in refrigerators they can be stored indefinitely and retain their good ductility. As production requirements demand they may be removed, formed and allowed to age harden at room temperatures. Within a few hours they will attain maximum strength and hardness.

The new Knapp furnace is an ingenious device for accomplishing the heating and quick-cooling cycles. Constructed of

(Continued on Page 24)

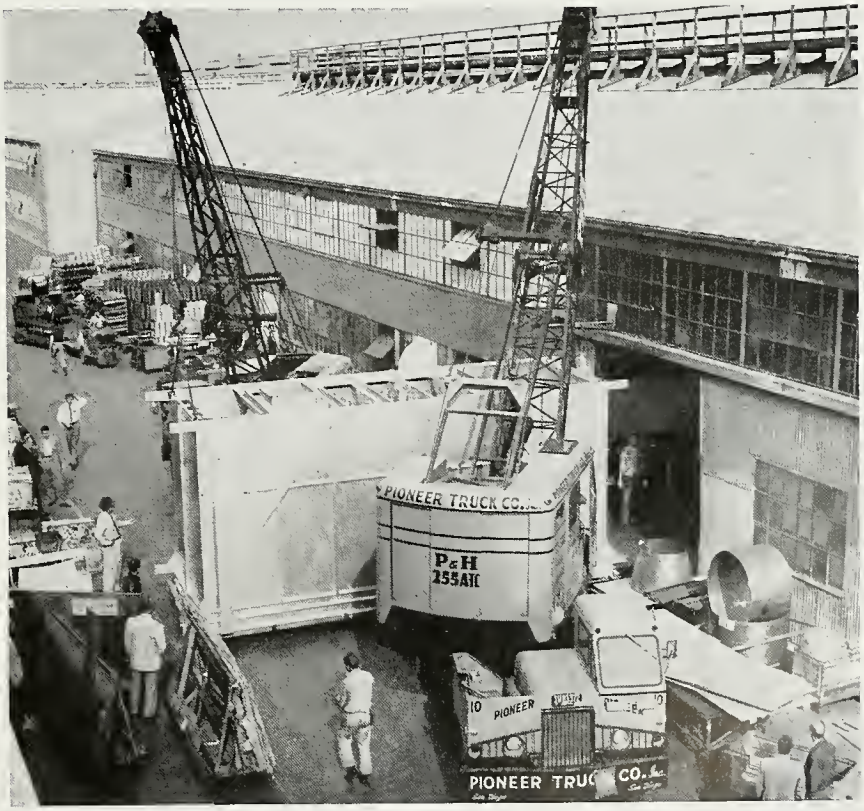
QUENCH FURNACE

ANOTHER roof-raising furnace has been installed at Ryan. Towering more than 25 feet high, the new heat treating facility is a modern type of "quick-quench" furnace which can douse hot parts into cold water within a six-second interval.

Designed by the James Knapp Company of Los Angeles, the unusual furnace is an elevated electric model which is charged from below. In this respect it is similar to the big General Electric furnace which Ryan uses to stress relieve stainless steel jet engine components. However, the Knapp furnace is designed for heat treating aluminum alloys and utilizes a 13,000-gallon water tank for quench-cooling them in an instant.

With the massive new unit Ryan has greatly expanded capacity for heat treating these alloys, previously confined to molten salt bath processes. This increase is in conformity with the enlarged production of aft fuselages which Ryan builds for Boeing C-97 Stratofreighter aircraft.

The heat treatment will be employed to render the alloys ductile for forming purposes. These aluminum alloys have the property of hardening with age after



One of the largest structures to come into the Ryan plant, the 22-foot heating compartment of the new Knapp furnace is lifted through the door with cranes.

RYAN JET TRAINER

(Continued from Page 7)

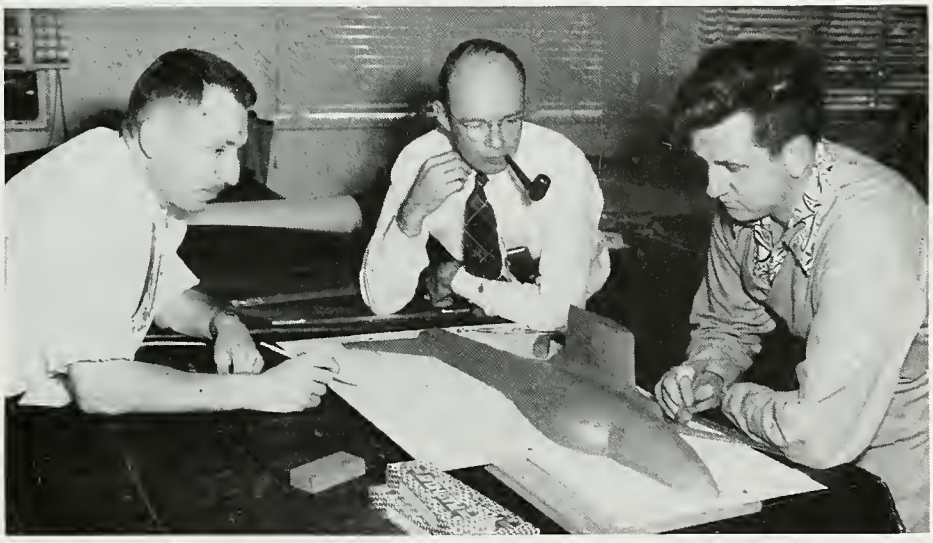
wing all metal planes of which 1500 were built for the Air Force and Navy.

The clean lines of the Model 59 bespeak simple construction. Wing span is 38.4 feet and length 28.04 feet. Empty weight is 3700 lbs., useful load 2292 lbs. and gross weight 5992 lbs. With tip tanks, useful load increases to 3602 lbs. and gross weight to 9455 lbs.

The structure, readily disassembled, consists of six major components, the forward fuselage, aft fuselage, wing center section, wing outer panels, wing tips and empennage assembly. In the aft fuselage is the engine tail pipe and supports for the tail surfaces. It is easily removable from the forward fuselage by a single bolt attachment at each of four longerons.

The wing center section is continuous and is attached to the lower portion of the forward fuselage by four readily accessible bolts. Four integral fuel cells are located between the spars in the center section, one on each side outboard of the landing gear and one on each side of the center of symmetry inboard of the wheels wells. In addition, a readily removable leading edge fuel cell is provided on each side.

The outer wing panel is of conventional two spar, rib and stringer construction. An integral fuel tank is provided between the spars. A one piece readily removable tip is provided, and it is possible to replace the wing tip with an external fuel tank.



Engineering team at Ryan examines clay model of company's new jet primary phase trainer. Left to right, Peter F. Girard, chief aerodynamics engineer and test pilot; William T. Immenschuh, executive engineer; and Richard Price, engineering illustrator.

RYNALLOY

(Continued from Page 18)

a snug-fitting assembly which permits the connecting tubes to slip, twist and rotate with universal action.

As many as 56 ball-and-socket joints are used to isolate the terrific vibration of huge power plants in aircraft. With these fittings it is possible to hang the weight of the exhaust system on the engine mount or nacelle rather than on the engine itself. The joints permit the engine to pitch and yaw with power surges and transmit that hot gases with good leak resistance. Also, they accommodate engine and exhaust system movement due to thermal expansion and contraction.

The ball-and-socket joint is a tortuous testing ground for metals because of its functional requirements. To prevent gas leakage, the components must fit together closely with a large area of metal-to-metal contact. In service, the metals rub together constantly due to the vibration and thermal movement which must be accommodated. At the extreme temperatures experienced, no lubricant can be provided to ease the friction of the hot rubbing surfaces.

Under these conditions, most cast metals will oxidize to form a scale which accumulates. With insufficient space to escape between the close-fitting components, the expanding oxide film either causes the joint to seize or encourages excessive wear. Consequently, the first requirement of the ball joint alloy is that it have good resistance to oxidation at elevated temperatures.

Another vital factor is the metal's coefficient of thermal expansion. This property must be similar to that of the stainless steel used in the attached tubes —usually Type 321. If the tube within the ball expands too rapidly under temperature, it will either break the ball or stretch it so that the tolerances are lost. If the ball expands too rapidly for the exterior tube, it will seize the joint.

Actually, there is a difference in the amount of expansion between the cast metal ball and the sheet metal tubes, even though their rates are equivalent, because of their difference in thickness. This disparity is compensated for in the design so that the joints are loose-fitting when cold, to permit greater freedom when the engine is rough-running, and tight-fitting when hot to provide maximum leak resistance when the peak volume of hot gases are being expelled.

Unfortunately, cast metal balls made of stainless steel are not useful for this application because they do not have good wearing properties at high temperature, exhibiting a tendency to gall. Defined as "fretting away by friction," galling occurs when the molecules of metal in intimate contact cling to each other. To prevent this phenomenon, the cast metal must contain graphitic flakes of carbon along the grain boundaries to allow the molecules of metal to slip over each other.

For years, the cast metal balls used in Ryan ball-and-socket joints have been made from International Nickel's Ni-Resist #2 and this excellent alloy is used for forty per cent of the present production of these components, where temperatures are within the design limits. With the introduction of the Douglas C-124 Globemaster II into service, a new problem presented itself in connection with ball-and-socket joints incorporated in the Ryan-built exhaust systems. This huge cargo transport is powered by four Pratt and Whitney R-4360 Wasp Majors—most powerful aircraft engines of their type. Developing 3800 horsepower for take-off, the R-4360 imposed higher operating temperatures on the exhaust equipment.

Since NiResist #2 is not recommended for temperatures above 1500°F., the International Nickel Company suggested use of NiResist #4. This metal has oxidation resistance properties which will permit its use at the required temperatures, but its coefficient of thermal expansion does not match the stainless steel used in the exhaust system structure.

NiResist #2 has a mean coefficient of thermal expansion of 10.28 millionths per degree F. which is close to that of type 321 stainless steel. NiResist #4 possesses a thermal expansion coefficient

(Continued on next page)

of only 8.5 millionths per degree F. which is insufficient for this application.

With suggestions from International Nickel, Ryan development laboratory metallurgists attacked the problem of synthesizing a cast alloy which would have the desired properties. Under the direction of Wilson Hubbell, chief metallurgist, several formulae were devised and a variety of heats were cast. Over the following months, the laboratory tested innumerable samples of cast alloys cast to prescribed proportions in an effort to find the one best fitted to withstand the high temperatures and grinding wear of the ball-and-socket joints.

Out of this research, Rynalloy was born. The new metal has been used in Ryan ball-and-socket joints for one year and has proved to have the stamina required. In arriving at its final formula a number of trends were observed.

The coefficient of thermal expansion is determined by the amount of nickel contained in the alloy. It was found that a nickel content of 20 per cent provided the correct thermal expansion. If the nickel component is less than 13 per cent, hard matensitic irons are obtained which reduce ductility and exhibit large volume changes upon heating and cooling.

Investigations showed that amounts of chromium should not be less than 1.8 per cent and that it is desirable to obtain compositions with more than this amount because the presence of this element increases oxidation resistance and refines the graphitic structure. On the other hand, too much chromium hardens the iron and lowers machinability.

Silicon is also used because its addition increases high temperature strength and oxidation resistance. Amounts in excess of 6 per cent are detrimental because silicon then affects ductility and machinability.

The percentage of carbon contained is limited to two-and-a-half per cent and the less carbon the better the strength and temperature resistance obtained. Graphitic carbon, deposited along the grain boundaries of the metal, is necessary to provide anti-galling characteristics.

Other elements are present in small amounts, but their quantities can affect the alloy's properties in a definite manner. Sulphur is undesirable and should be restricted to the lowest possible amount. Manganese acts like nickel in making the alloy austenitic, but it possesses the undesirable property of reducing resistance to scaling. It should be present in quantities sufficient to counteract whatever sulphur is contained, but not above one per cent. Because phosphides in iron melt at 1760°F., greatly reducing metal strength, phosphorous should be maintained at the lowest possible proportion.

One of several groups which toured Ryan plant recently under American Welding Society auspices is shown with Ford Lehman, right, Ryan welding engineer, at pressure test rig for Continental engine manifolds.

American Welding Society Visits Ryan

One hundred and twenty members of the American Welding Society visited Ryan recently and were impressed with what they saw. Drawn from the Aircraft and Rocketry panels of the Los Angeles and San Diego sections of the Society — America's top professional group of welding authorities — the guests came to inspect the company's modern facilities.

Herbert Clemens, Chairman of the Los Angeles Section, and Francis Stevenson, Chairman of the Aircraft and Rocketry Panel, led the group from Los Angeles, which comprised two-thirds of the visitors. Thirty-six southland companies were represented by the guests including Douglas, Convair, Lockheed, North American, Aerojet, Standard Oil of California, the U.S. Air Force, University of California at Los Angeles, U.S. Naval Ordnance Test Station and many others.

The group were served dinner in the Ryan cafeteria and briefed upon the 31-year history of Ryan and its present manufacturing activities. After dinner, the guests were divided into groups of ten each and conducted through the plant by Ryan guides who were selected because of their understanding of welding techniques. After the two-hour plant tour, the guests reassembled in the cafeteria for a coffee and question period to clarify any questions which the tour may have raised.

Francis Stevenson, left, chairman of the American Welding Society aircraft and rocketry panel, Los Angeles section, and Herbert Clemens, chairman of the A.W.S. Los Angeles section, confer with William Immenschuh, Ryan executive engineer, standing, and Earl D. Prudden, vice president.

Members of the A.W.S. group were enthusiastic in their comments concerning Ryan's effective use of welding processes and the wide variety of 91 resistance welding machines and 164 fusion welding stations in the plant. Arrangements for the tour were made by Robert Fullerton, Ryan welding engineer and company member of the American Welding Society.

Rynalloy balls are sand-cast at about 2350°F. with a dimension which is 1/16-inch oversize to allow for machining. They are machined, inside and out, to a finish of 100 RMS and dimensional tolerances are held to .002".

Recently, Ryan has developed another method for attaching the cast Rynalloy balls to the stainless steel tube which is inserted inside the joint. This is now accomplished with inert arc welding methods utilizing a specially-built welding machine. This device attaches the balls to the tubes in a permanent way and reduces the amounts of time and labor formerly required for the operation.

TUBE FORMING

(Continued from Page 1)

were welded together. The weld beads were ground smooth at the tubes ends so that attachment clips could be slipped on. While this method of fabrication produced a satisfactory tube it did not lend itself to the volume production which stepped-up tank orders required. Each installation required 140 inches of manual welding which involved extra time and costs. Also, the welded tubes were susceptible to splitting during bending operations and had to be handled with care.

On the first approach to the problem the Ryan production engineering division attempted to blow the tube into shape with the aid of accurately cast die blocks. A cap was welded on one end and hydraulic pressure was exerted within the tube which was placed in the die block. This solution did not prove practical because springback in the oval sections, which could not be eliminated nor accurately compensated for, caused tube distortion.

Additional study indicated that the job could be accomplished with seamless, 2-inch diameter tubing if a two-stage forming procedure were employed. In the first stage the tube would be expanded in diameter so that the cross-sectional area of the final elliptical shape would be equal to that of the original circular tubing. Then, a method would be worked out for forming the irregular sections in finisher dies. This technique proved to present a challenge in the form of precise coordination between the dies to cover the transition areas between the different size diameters of the tube.

In actual practice, the seamless 2-inch tubing is cut to length, allowing one inch extra to compensate for the shrinkage occurring when the sections are expanded in diameter. The tubing must be free from scratches or other defects. After cutting, the ends are burred and the tube is annealed to insure uniform results.

Next, a steel shaft, connected to a hydraulic pressure unit, is inserted in the tube. The shaft has piston-like fittings on both ends. Sealing is effected by means of "O" rings set in tandem grooves in these fittings. The tube and shaft are placed in a steel die which is designed to allow the central portion of the tube to expand to a diameter of two-and-one-quarter inches. Then the whole assembly is placed in Ryan's 250-ton HPM hydropress. This press was selected because its ram may be brought down to close the die and hold it at the required 50 tons of pressure during the expansion cycle.

Hydraulic fluid is pumped into the steel shaft until a pressure of 900 to 950 p.s.i. is indicated. Flow direction is immediately reversed, the die is opened and the expanded tube removed. A simple pet-cock on the shaft permits the excess fluid to be drained off before removing the shaft from the tube.

The expanded tube is now the proper size for forming into an elliptical shape having the same cross-sectional area as the original 2-inch diameter section. The elliptical forming is accomplished in a die and finisher die in the drop hammers. To prevent the tube from wrinkling, it is filled with melted paraffin and allowed to stand in refrigerators until the paraffin has solidified. The parts are then placed in the dies and struck by the drophammers. Under the impact, the paraffin exhibits the correct amount of resistance to prevent wrinkling or buckling of the metal and to permit the desired deformation. The tube sections emerge from the dies as smooth, tapered components of prescribed dimensions.

Ryan production engineers experimented with ice as a backing medium and found that it performed well but the tubes were not as smooth and blemish-free as when paraffin is used. The tubes were filled with water and refrigerated so that the ice formed within them before they were placed in the drophammers.

A number of commercial compounds are available which are successfully used for tube bending operations but which did not prove satisfactory for this type of deformation. These compounds exhibited too much resistance to flow under impact and restricted the tube so that full deformation was not achieved.

The new Ryan technique has permitted the volume production of these components and saved a substantial percentage of their cost. Including all tool costs, the method has resulted in a net saving of more than $15,000 per thousand tubes formed.

Future of Firebee Development Discussed

The future development program of Ryan's sensational pilotless jet propelled target plane, the Firebee, was discussed recently at a conference with Air Force officials in the Ryan plant.

Left to right, J. M. Moore, civilian project officer for the Air Force; Forrest Warren, Jr., Q-2 project engineer; Lt. Col. Richard Gooch, chief of the drone missiles branch, Wright Air Development Center; Gabe Danch, executive assistant to the Ryan engineering director; and J. E. Gleason, of Ryan contract administration.

QUICK-QUENCH

(Continued from Page 21)

welded steel plates, lined with firebrick, it is supported eight feet above the factory floor on sturdy steel columns. It was necessary to raise the factory roof in order to accommodate the upper extremities of the structure.

The compartment is lined with continuous heating elements of nickel chrome alloy which consume 380 kilowatts to give the furnace rapid performance. Parts are loaded into the heating compartment by means of a pneumatic ram which hoists them vertically through the furnace bottom. Two sliding doors, rolling together on horizontal tracks, seal the furnace.

The entire installation is located over a pit which is 23 feet long, 7 feet wide and 11 feet deep below the factory floor. This cavity is designed to contain the water for quench-cooling. The pneumatic ram has a travel of more than 16 feet which is sufficient to take a 750-pound metal load from the furnace to the quench tank and immerse it in water. For loading the furnace, the ram can be stopped and locked at floor level so that carts or racks of metal may be rolled onto the hoist.

Fully automatic with push-button controls, the furnace incorporates several unique features. It has been designed

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to maintain temperatures within a plus or minus 5°F. of specified settings. This is effected by means of two huge blowers, each powered with a 30-horsepower electric motor. These blast a flow of air through air-flow diverters which picks up the heat from the elements and distributes it uniformly throughout the furnace compartment.

Uniform temperature is an important requirement in this type of heat treating. In order to save time, it is desirable to heat the alloys as hot as possible within a safe range. If the aluminum is heated to slightly too high a temperature the grain boundary constituents will melt and render the alloys useless. These constituents, which were last to solidify when the alloy was formed, have the lowest melting points of the ingredients and are most susceptible to over heating.

In the case of clad aluminum alloys, such as 24S, too much temperature causes the copper to diffuse into the clad coating and converts the alloy into an unclad type.

Another special feature of the furnace operation is the automatic arrested descent of the parts load immediately prior to immersion. Ram action is speeded to lower the metal at a rapid pace. However, since the hot, soft aluminum could be badly distorted by impact with the water, this movement is momentarily arrested and the parts are gently lowered into the pool.

Ryan metallurgists have requested an added accessory for the big furnace which is also designed to prevent distortion from uneven cooling. This is a water spray system which is located midway between the furnace bottom and the quench pit surface. After the hot metal is removed from the furnace, the ram will be stopped at floor level and the parts will be spray-quenched from rows of nozzles directed inward. A 40-horsepower motor driven pump will feed water from the pit to these spray nozzles.

Spray-quenching will reduce distortion to a minimum because the cooling process occurs with uniform effect upon all parts of the metal. In the immersion cooling action, the part of the metal which first enters the water cools before the remaining part. Some distortion is unavoidable for this reason.

The new facility is equipped with automatic protective devices. The ram cannot be raised or lowered unless the furnace doors are open. The heating elements cannot be switched on until the blowers are operating. Basically, this type of heat treating facility is safer than any other because it does not involve combustion nor the use of molten salt.

VISITING AND VISITED

"Firebee" Subject of Navy Conference

Navy officers from Point Mugu and the Bureau of Aeronautics recently conferred with Ryan representatives regarding the "Firebee" program. The remote controlled, jet plane target project has been jointly sponsored by the Navy, Air Force and Army. Left to right, Lt. George Miller, Lt. Comdr. Ralph Moyer, Ron Reasoner, Curtis L. Bates, and Forrest Warren, Jr., of Ryan engineering; and Lt. Comdr. Jerry Huestis.

Boeing Visitors View Ryan Production

Interested in all phases of Ryan production, Fred Laudan, vice president in charge of production at Boeing's Seattle plant, inspects G.E. jet engine aft frame on recent visit. Left to right, John Brockway, Southern California purchasing representative for Boeing; John van der Linde, Ryan production manager; Larry Limbach, works manager; Laudan, and T. Claude Ryan.

Ryan Guests of Convair Officials

Ryan officials recently were guests of Convair executives in a tour of the Convair plant. Shown at a T-29 type navigational trainer are, left to right, Earl Prudden, Ryan vice president; A. P. Higgins, Convair works manager, Plant 2; B. F. Coggan, Convair San Diego division manager; T. Claude Ryan; J. T. McNarney, Convair president; Larry Limbach, Ryan works manager; and W. L. Young, Convair factory manager, Plant 1.

MACHINE SHOP "LAUNDRY"

(Continued from Page 17)

One of the most elaborate operations of its kind on the west coast, the recently installed battery of four giant Roto-Finish "tumbling" machines already has processed millions of parts for jet and piston aircraft engines.

An analysis of their first two months' activity has been completed by James N. Willits, Ryan methods engineer who supervised the machines' installation and training of operators. This survey has led to an estimate that as much as $100,000 a year may be saved on deburring operations alone, based on the present average work load.

But the machines have various other applications. Surface corrosion, fused weld flux, and heat treat scale are being removed, obviating the need for the more cumbersome and slower sandblasting method.

One of the most time-consuming sequences in the Ryan assembly flow has been the hand-finishing of the numerous parts which form jet engine components or piston engine exhaust systems. Polishing and buffing wheels, grinders, files, scrapers — these have been the long-accepted means of smoothing off the edges left rough by machining. While other stages of the production routine were highly mechanized to attain peak efficiency and volume, deburring remained a potential if not an actual bottleneck.

The solution has been provided by the "laundry in the machine shop."

In mechanical tumbling, hundreds of parts are simultaneously smoothed and polished in a gently abrasive action of grinding chips (stones) and detergent compounds. As the parts are mixed with the chips and the chemical compounds in the rotating cylinder, the burrs, tool marks and other projecting edges and imperfections are gradually worn away. For each type of metal, a different time cycle is established, ranging from minutes to hours. The mild grinding goes on automatically and constantly, with one or two operators able to handle several machines.

Larger parts, which would be damaged if "free-tumbled," are clamped into a fixture, several at a time, and held stationary in a machine adapted to this use. The chips then tumble against the parts, which remain in one position in the machine as it revolves.

The grinding chips are of three types —aluminum oxide, granite and limestone —and come in different sizes. The type of stone and its size are dictated by the job to be performed. Large chips cut faster, but small chips result in a smoother finish and are able to grind areas not accessible to the larger stones.

At Ryan, the chips are stored in eight large bins, from which they are dumped into hoist pans on casters. A crane lifts the hoist pan and inserts its nose into an opening in the "tumbling" machine. Then a detergent compound in water is poured into the cylinder. During the tumbling action, the burrs are likely to rub off onto the abrasive chips, which in turn may reapply this loose metal back to the parts, resulting in a dull, lustreless finish. The detergents, by lowering the surface tension of the water enable the liquid to wet the parts better, get "under" the dirt and grime, and then keep the metal waste in suspension.

As with the chips, different kinds of detergents are prescribed, depending on the types of metal in the parts. The detergents range from mild, surface-conditioning powders to strong acid compounds for removal of heat treat scale. Many of the detergents are obtained from the tumbling machinery manufacturer, but Ryan has developed its own compound — designated Raco 210 — for removal of fused weld flux and for particularly bright finishes on stainless steel parts.

Created in the Ryan laboratories, Raco 210 is a formulation of acids and wetting agents, originally developed for use in the final cleanup of large stainless steel assemblies, where discolorations, shop blemishes, etc., are removed. It was found admirably suited as a detergent compound in the "machine shop laundry."

At given rotation times, an automatic timer stops the machine, and the parts and chips are unloaded into the hoist pan. A variable speed control governs the rotation pace, which is usually slower with heavier parts, to prevent damage in the tumbling action. After unloading the parts are separated from the chips in a mechanical separator, and the chips are screened as to size. The chips may be used over and over until they are too small for practical application.

Whether the objective is grinding, deburring, de-scaling, polishing or high, mirror-like coloring, the "laundry in the machine shop" is getting the job done on a mass production basis at Ryan.

View Engineering Project

An engineering project at Ryan was viewed with great interest this month by these key Navy officers, shown with Bruce Smith, director of engineering. Left to right, Capt. Cedric Stirling, San Diego representative of the Bureau of Aeronautics; Smith, Comdr. S. S. Sherby, chief of the fighter branch, Bureau of Aeronautics; and Lt. Comdr. J. Davidson, of the office of naval requirements, Chief of Naval Operations.

EXPAND FORMING

(Continued from Page 9)

sistently and accurately duplicated. And, it is more economical than conventional methods because the aluminum shoes used for forming to different contours are less expensive than other types of tooling, and no excess material is wasted as "flash" to be trimmed away.

Long used as a shop tool in the Ryan plant, expanding mandrels have been employed to size exhaust system tubes, form beads and similar shapes in stainless steel ducting. However, these applications are concerned with small sections which may run from three to six inches in diameter. The mandrels which perform these tasks are air pressure operated to exert forces up to 10 tons.

When Ryan tool planners were called to develop a method for fabricating the huge circular sections for the mammoth Ryan wing tanks they thought of the small expanding mandrel. If the action of this tool could be adapted to the dimensions of the aluminum alloy tank, it might do the trick. No one had built a mandrel with the 3 to 4-foot diameter required to stretch such big sections and they had never been used for this type of application.

Ryan designers drew the plans for a mandrel which would shove metal around with 568 tons of force and had it built to specifications by the National Steel and Shipbuilding Corporation of San Diego. With this machine they tried out the fuel tank forming. It proved eminently successful. Not only were the straight-sided sections stretched to exact diameter by the new tool but the elliptically-curved sections were pressed into contour with perfect results.

Plant engineers were soon poring over their drawing tables laying out plans for a bigger expanding mandrel—this time a 1200 ton job which would be used to

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speed up production by the Ryan tank. It, too, proved out. Its performance was so gratifying that it was decided to adapt the technique to the building of large jet engine components.

Made from tough, heat-resistant stainless steel alloys, these parts require Herculean force to stretch-form. To exert these tremendous pressures, Ryan engineers conceived a behemoth of welded steel which has a 4800-ton push. Constructed by the Waldrip Engineering Company, of Hollydale, California, this massive new tool stands seventeen and a half feet high and tips the scales at 34,000 pounds. Its three major assemblies are welded together with more than 1,000 pounds of weld metal. Three welding shifts, operating continuously for nine days, were employed to fabricate one assembly.

The source of the Ryan mandrel's power is a huge hydraulic ram. Forming the central assembly, a hydraulic cylinder, 18½" in diameter, contains the big piston which does the work. Hydraulic fluid under 5,000 p.s.i. is forced into this cylinder to bring it down. As it descends, the piston pulls a heavy shaft connected to a tapered pin at the top of the machine. This pin expands a set of eight large nickel-iron segments with aluminum alloy shoes which fit snugly around its circumference. The cone-shaped jet engine components are placed over these shoes where the radial force of 4800 tons is available to stretch them into size and shape.

A primary requirement of the tool's use is its precision. To effect this, Ryan designed the mandrel so that the movement of the main shaft would be limited by four steel collars which can be adjusted. Threaded on steel columns, these collars are raised or lowered by turning wheels which are chain-connected to the columns by integral sprockets. One revolution of the turning wheels results in a change in diameter in the mandrel shoes of .025". Fractional adjustments of as little as .005" in diameter can be easily obtained.

Major credit for originating the new forming innovation belongs to Richard E. Grabowsky, Factory Services executive, who has conceived a number of valuable production methods. The job of designing the unprecedented expanding mandrels was successfully tackled by C. C. Hasty, Design engineer. H. F. Wallen, Tool Design supervisor, worked out the plans for the big machine's tooling.

With the new, more powerful machine, alloys of stainless steel as well as aluminum may be processed. Aluminum skins can be formed in the SW condition or in the SO condition and heat treated afterwards. Ryan designs the component sections slightly smaller than required so that they can be stretched out to exact dimensions.

It is interesting to note that the big mandrel has a capacity for exerting stresses that approach the effectiveness of large hydro presses which are much bulkier. The 5,000 p.s.i. hydraulic oil which is fed to the mandrel has the highest operating pressure of any fluid in the plant.

Created to build a specific product—the Ryan external fuel tank—the sizing technique and mammoth mandrel are pushing on to meet new challenges. In a world dedicated to greater speed, sleek cylindrical shapes seem to be the order of the day. The Ryan method is streamlined to fill this growing need.

TURBINE HOODS

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tachment is made by means of Ryan-made stainless steel clamps.

Each turbine hood assembly is made from five irregular stainless steel stampings formed in drophammers. These are welded together with inert gas-shielded arc welding. The weld seams are ground smooth around the hood opening so that the flange can be welded with electric seam welding electrodes.

Exact trimming of the hood is performed in precision fixtures and all openings are sized in hydraulic expanding mandrels to maintain dimensions within a plus or minus ten-thousandth of an inch.

The rough-machined flange is spot welded into the hood with a Ryan devised portable machine which utilizes a Linde inert gas welding gun. Then, it is permanently seam welded into place with electric welding equipment. Finally, the flange is finish-machined, the outlet section is arc welded to the hood and the structure is readied for shipment.

The development of the Wright turbo-compound engine has again focused the eyes of the aviation world upon *efficiency* in power plants. With turbo-jets passing 10,000 pounds of thrust and afterburners adding thousands more, thrust-producing engines have eclipsed piston type power plants in the race for power.

However, pure power is all-important only to military aircraft. In the realm of commercial airliner and cargo transport operations, economic factors and operating efficiencies are still a prime consideration. Undoubtedly, further development of turbo-jets will enhance their efficiency so that they will be economically competitive by the time airliners fly in the transonic region. In the meantime, there is still a substantial period of commercial operation in which the Wright turbo-compound will be welcomed because of its money-saving capabilities.

Rated as the world's most efficient power plant produced in quantity, the R-3350 generates more than one horsepower for each cubic inch of its displacement. It utilizes twice as much of the heat energy in the fuel consumed as the turbo-jet type of engine. This facility gives present airline operators a distinct economic advantage. In some cases, where long range is a factor, the turbo-compound engined-aircraft can actually trim the time required by jet-powered airliners. For instance, it is evident that the new Douglas DC-7 or present Lockheed super Constellation airliner could clip several hours from the 23 hours and 40 minutes which the British Comet jet airliner now takes to fly the 6700-mile route from London to Johannesburg, South Africa. Although their cruising speeds are somewhat lower than the Comet's, the efficient Wright turbo-compound power plants of these airliners would enable them to fly the route with only one stop midway while the Comet's extravagant engines make five re-fueling stops necessary.

PARTS ALOFT

(Continued from Page 3)

Power for the conveyors is supplied by electric motors, also mounted overhead, which are geared to drive the conveyors at the required speeds. The jet components lend themselves to this type of conveyor system because they are small and light-weight enough to be lifted to and from an overhead attachment.

As the conveyors thread the parts to each station, employees have easy access to them without having to reach, wait or look for the next assembly. No confusing array of parts batches surrounds the employees nor confronts him with questions concerning their disposition. Every component arrives in its proper sequence. None can be mis-routed or lost.

The new system has reduced delays in getting parts to each fabrication station and stimulates a more uniform flow of parts through the department. As a result of the sizable parts handling savings, the same production can now be accomplished with thirteen percent less manpower. This saving in time can be credited to the conveyor systems because all fabrication methods are the same as they were before the new installation.

Parts quality has been improved. Each component is now handled individually, and not placed in close proximity with others where jostling can cause scratches or other blemishes.

JET METALS

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Fortunately, corrosion resistance is the least important obstacle to hurdle in the quest for high temperature materials because the elements which provide metals with good oxidation resistance also contribute to their capacity to resist corrosion. Chromium and nickel, present in almost all high temperature alloys, contribute greatly to their resistance to both oxidation and corrosion. The only exceptions to this are the alloys in which carbide precipitation occurs under elevated temperature. In these metals, a stabilizing agent such as columbium or titanium is added in order to prevent the formation of a harmful carbide network which could provide a path for intergrannular corrosion.

Actually, oxidation is a specialized form of corrosion — a hot corrosion in which a black "rust" or oxide is formed rather than the familiar types of corrosion oxides which occur at normal temperatures.

SPECIALIZING in the manufacture of high temperature components for piston, jet and rocket engines, Ryan has accumulated an intimate knowledge of the high temperature alloys which rivals that of any other company. For years the Ryan development laboratories have worked closely with the steel mills in developing research data which would serve as a guide to the evolution of new alloys. Ryan ordered the first batches of 18-10 chromium-nickel stainless steel in the aircraft industry and introduced 19-9DL stainless steel in sheet form to aviation applications.

Today, Ryan production is utilizing 21 high temperature alloys in the fabrication of components for power plants. These metals may be classified into four groups: the chrome-nickel steels, chrome steels, nickel base alloys and cobalt base alloys.

CHROME-NICKEL STEELS

THE chrome-nickel steels contain these elements in approximately 18-8 ratios and are commonly referred to as austenitic steels. This description refers to their crystalline structure in which the ingredients are said to be in solid solution so that each crystal is composed of an intimate mixture of the constituents.

This group of steels is most widely used for high temperature applications because of its good characteristics of oxidation and corrosion resistance and high strength at elevated temperatures. These steels have about six times the electrical resistance of ordinary steels and respond readily to welding techniques. However, since they expand fifty percent faster, and conduct heat only half as fast, as plain steels they require special care during welding to prevent distortion. They do not need heat treatment after welding to develop maximum physical strength.

They are non-magnetic and cannot be hardened by heat treatment. They may be hardened by cold working and then become slightly magnetic. Cold working enhances their structural strength at the cost of ductility. These steels are difficult to machine unless they contain added amounts of sulphur or selenium.

When subjected to temperatures above 800°F. they tend to precipitate carbides in their grain boundaries, lowering their resistance to corrosion. The corrosion resistance may be restored by heating them to 1850-1900°F. and cooling them quickly or they may be protected against the formation of harmful carbide precipitation by the addition of columbium or titanium to their formulae.

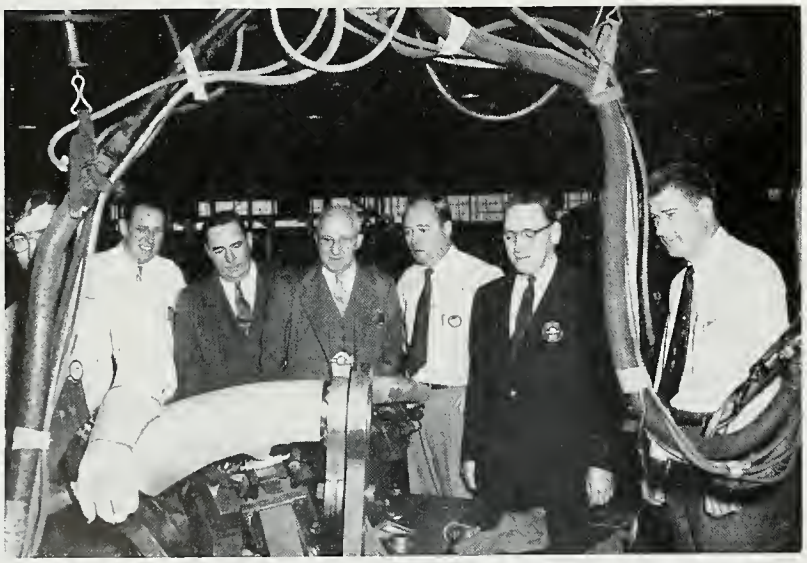
From this group Ryan builds a variety of jet and piston engine components. High temperature exhaust systems for Douglas DC-6 and Convair 240 and 340 airliners are fabricated from 19-9DL stainless steel. Ryan-built aft frames and ceramic coated combustion chambers for General Electric jet engines are made from 321. Huge exhaust systems for Pratt and Whitney R-4360, 3500-horsepower piston engines are built from type 310. For critical carburetor heat take-off tubes, in Continental tank engines, and turbosupercharger waste gate valves for Boeing C-97 Stratofreighters, Ryan uses Haynes Stellite N-155 alloy.

Normally type 347 stainless steel is consumed in large quantities at Ryan because of its excellent qualities but it has been temporarily supplanted by other types because of the scarcity of columbium. From type 316, Ryan makes complex case weldments for a new Pratt and Whitney jet engine. Various port flanges and other fittings for exhaust system equipment are fashioned from types 302 and 304, where the applications do not involve extreme temperatures, because these alloys are unstabilized. Where good machining is a requisite, type 303 stainless is employed.

CHROMIUM STEELS

THE straight chromium steels, containing no nickel, are either martensitic or ferritic in crystalline structure, depending upon their hardening characteristics. Those containing up to 14 percent chromium harden intensely if they are allowed to cool rapidly from high temperatures, forming a hard, relatively brittle substance called martensite. Because they respond to heat treatment they are capable of being given a wide range of mechanical properties such as tensile strength, hardness and so on.

Those chromium steels containing from 17 to 30 percent chromium do not re-



Ryan manufacturing methods were viewed recently by officials of Westinghouse Electric Corp.'s jet engine plant in Kansas City. One of Ryan's major new projects is production of afterburners for a Westinghouse engine, on which output is being accelerated. Left to right, Larry Limbach, Ryan works manager; Harlan Printz, Westinghouse manager of fabrication; Sam Stine, general manager of the Kansas City plant; Henry Berlinghof, Jr., of Ryan works engineering; W. G. Shepherd, Westinghouse manager of quality control; and Jack Zippwald, assistant director of Ryan customer service.

spond to heat treatment or cooling and remain essentially ferritic at all times. The intermediate types, containing between 14 and 17 percent chromium, behave in a manner which depends upon their exact chromium and carbon contents.

In the straight chrome group, corrosion resistance is a function of the amount of chromium dissolved in the iron. Chromium contents up to 4 percent do not increase corrosion resistance. Amounts from 4 to 10 percent improve resistance to corrosion appreciably. Chromium percentages from 10 to 30 percent are designated when oxidation resistance at high temperatures is required.

The steels with chromium contents of from 5 to 30 percent are magnetic in all conditions. They exhibit distinctly inferior creep resistance compared with the chrome nickel stainless steels. The 17 percent chromium steels have excellent oxidation and corrosion resistance and may be used at temperatures up to 1550° F. The 25 percent chromium content series are designed for severe heat and corrosion applications and are good for applications where temperatures reach 2000°F.

All of the straight chrome steels are more difficult to weld than the chrome-nickel types because the welding heat leaves them in a brittle condition. They have about the same coefficients of expansion as ordinary steel, with several times the electrical resistance and slightly lower melting points. They tend to become brittle from welding heat in two ways. By slow cooling from around the 1200°F. range and by grain growth produced by holding them over 1650°F. The first type of embrittlement may be eliminated by quick cooling from above 1200°F. The second type cannot be remedied but may be avoided by careful welding techniques.

From straight chrome steel, Ryan is building jet engine case weldments and bearing housing assemblies for Pratt and Whitney jet engines. These are fabricated from welded alloys of type 410. Additional jet engine detail fittings and components are built from type 416 and used in applications where temperature is not a critical factor.

NICKEL BASE ALLOYS

THE nickel base alloys contain between 70 and 80 percent nickel and cannot properly be called steels because of their small quantities of iron. In this group are Inconel, Inconel X and W and Hastelloy C. These alloys have been tailored for high temperature and offer excellent oxidation and corrosion resistance at temperatures up to 2100°F. Inconel is a wrought, nonmagnetic nickel base alloy which does not lose its toughness or ductility, due to internal structural changes, even after long exposure to high temperatures. It is particularly useful for service involving high temperature where cyclic heating and cooling and large temperature gradients exist.

Inconel may be cold-worked, hot-worked or forged without difficulty and can be welded and machined satisfactorily. Because of its advantageous properties, Ryan builds combustion chambers and transition liners for General Electric J-47 jet engines from this rugged alloy. Also, Douglas C-47 exhaust systems are fabricated from the same metal.

Inconel X was developed as a heat-treatable form of Inconel with vastly superior mechanical properties, particularly between 1200° and 1500°F. The 1000-hour stress rupture strength of Inconel X is from four to six times that of Inconel in this temperature range while its creep strength is from six to seven times greater. Above temperatures of 1500°F., Inconel has somewhat better resistance to oxidation than Inconel X.

Inconel X is unusually strong at both ordinary temperatures and red heat and retains its strength beyond the drawing temperatures for steels that are suitable for high temperature use. Its special properties are achieved by heat treatment rather than cold working. This is an advantage because greater uniformity of properties, from center to surface, may be obtained through heat treatment than with cold working which has more effect on the surface of the material.

Inconel X may be hot and cold worked satisfactorily. It requires annealing if shapes to be formed are deep. Machining Inconel X is satisfactory but more difficult than with Inconel. The alloy lends itself to all welding processes except gas welding, which requires special techniques.

Ryan builds large afterburner structures for General Electric J-47 jet engines and waste gate valves for turbosupercharger-equipped C-97 Stratofreighters from Inconel X and Inconel W. Inconel W is similar to Inconel X in formula and behavior except that it contains no critically short columbium.

Another nickel base alloy which is coming into greater use is Hastelloy C. This metal has substantial amounts of chromium and molybdenum as alloying elements. It is exceptionally strong and oxidation resistant at high temperatures up to 2100°F. It has demonstrated successful performance in parts that are highly stressed or subjected to repeated thermal shock resulting from quenching at temperatures ranging from 1600° to 1800°F. It can be machined and welded satisfactorily and has fair forming characteristics. Ryan builds afterburner assemblies from this specialized alloy.

COBALT BASE ALLOYS

THE cobalt base alloys have been properly dubbed the "super alloys" because of the generous amounts of hard-to-get materials which they contain such as tungsten, cobalt, nickel and chromium. Because these alloys are expensive and often present fabrication obstacles, they are used in critical applications where their exceptional properties outweigh these other factors. Ryan uses Haynes Stellite No. 25 to build the eyelid assemblies used in the General Electric D-17 afterburners and the flame holders which are another part of the same structures. HS-25 has excellent strength and resistance to oxidation at high temperatures. It also exhibits good ductility and can be worked both hot and cold with a formability comparable to type 347 stainless steel.

Haynes Stellite No. 25 has an ultimate tensile strength of 155,000 p.s.i. and a yield strength of 70,000 p.s.i. Its stress rupture strength at 1700°F. in 100 hours is 11,000 p.s.i. and 7,000 p.s.i. at 1800°F. for 1000 hours. It has good oxidation and carburization resistance for service up to 1900° F.

These are the metals and alloys from which today's jet engines are built. Their behavior under extreme temperatures and stresses accounts for the amazing speeds and power which modern jet power plants are imparting to aircraft, missiles and rockets. As this performance is stepped up in the inevitable march of science, new metals and alloys, not now conceived, will emerge from the metallurgical laboratory to assume these stellar roles.

—William P. Brotherton

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Form 3547 requested

Latest product of creative Ryan aircraft engineering and manufacturing is the FIREBEE, the newest high-speed, high-altitude jet-powered aerial target plane. The FIREBEE is remote controlled and recoverable by parachute.

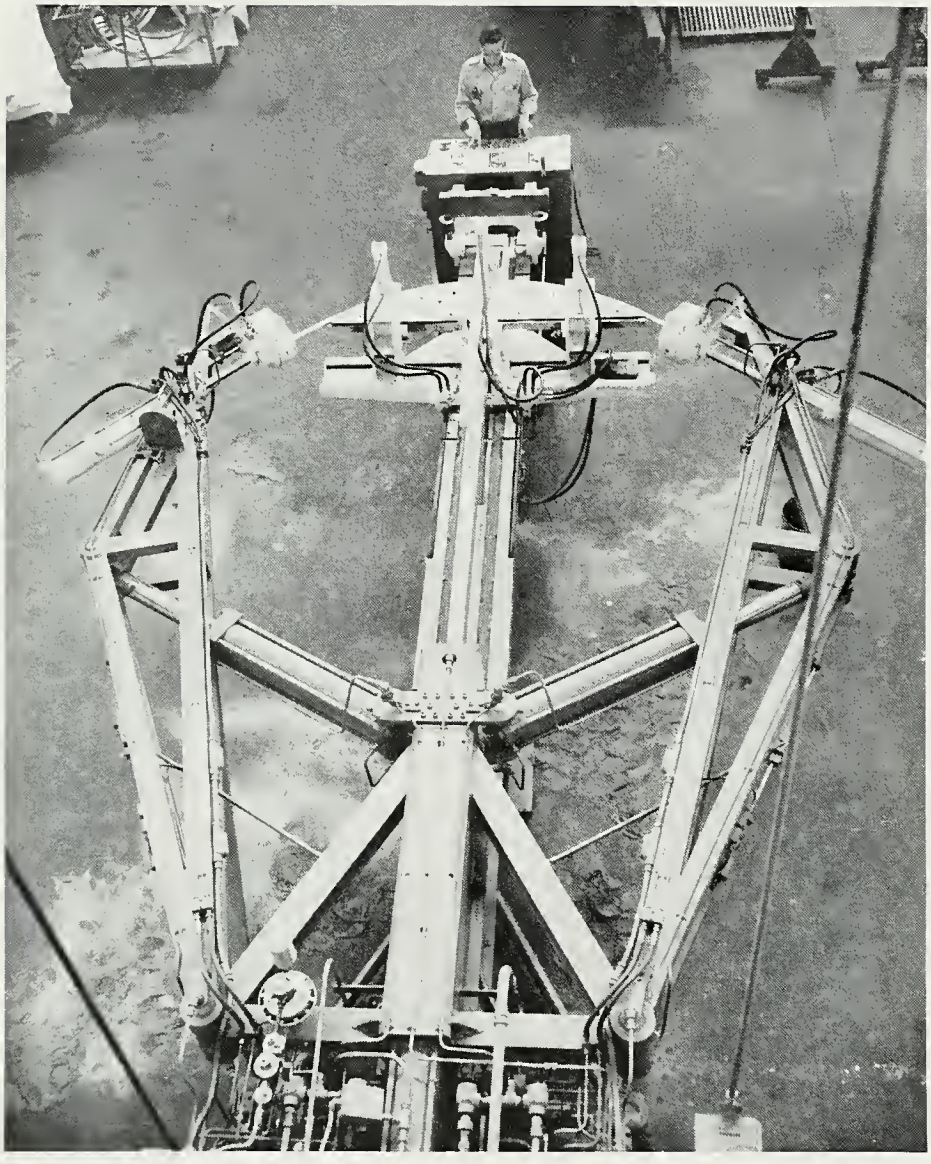
This new advance-type swept-wing jet aircraft has been developed as a jointly sponsored project of the Air Force, Army and Navy. It provides all the Armed Forces with an efficient answer to the vital need for a jet target with the performance characteristics of modern fighter aircraft.

The FIREBEE is another example in the long list of Ryan contributions to the advancement of aeronautical science.

RYAN
AERONAUTICAL COMPANY
AIRCRAFT AND AERONAUTICAL PRODUCTS

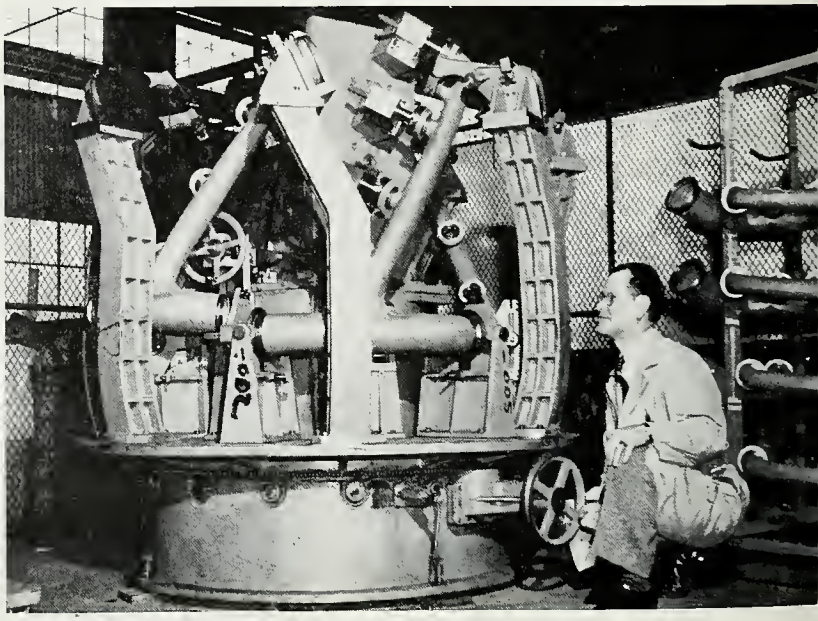
Ryan REPORTER

VOL. 14, NO. 4



With new Sheridan stretch press, Ryan wrap-forms extrusions for Boeing C-97 fuselages. Edward Carr operates machine which forms aircraft structures into large radius contours without hand working.

Bill Davies adjusts unique new Pratt and Whitney precision fixture which checks Ryan exhaust systems to .015" accuracy. Built for Wasp Majors, these are largest single-piece systems ever made.



It takes the best machines and the best craftsmen to produce the wide variety of Ryan products

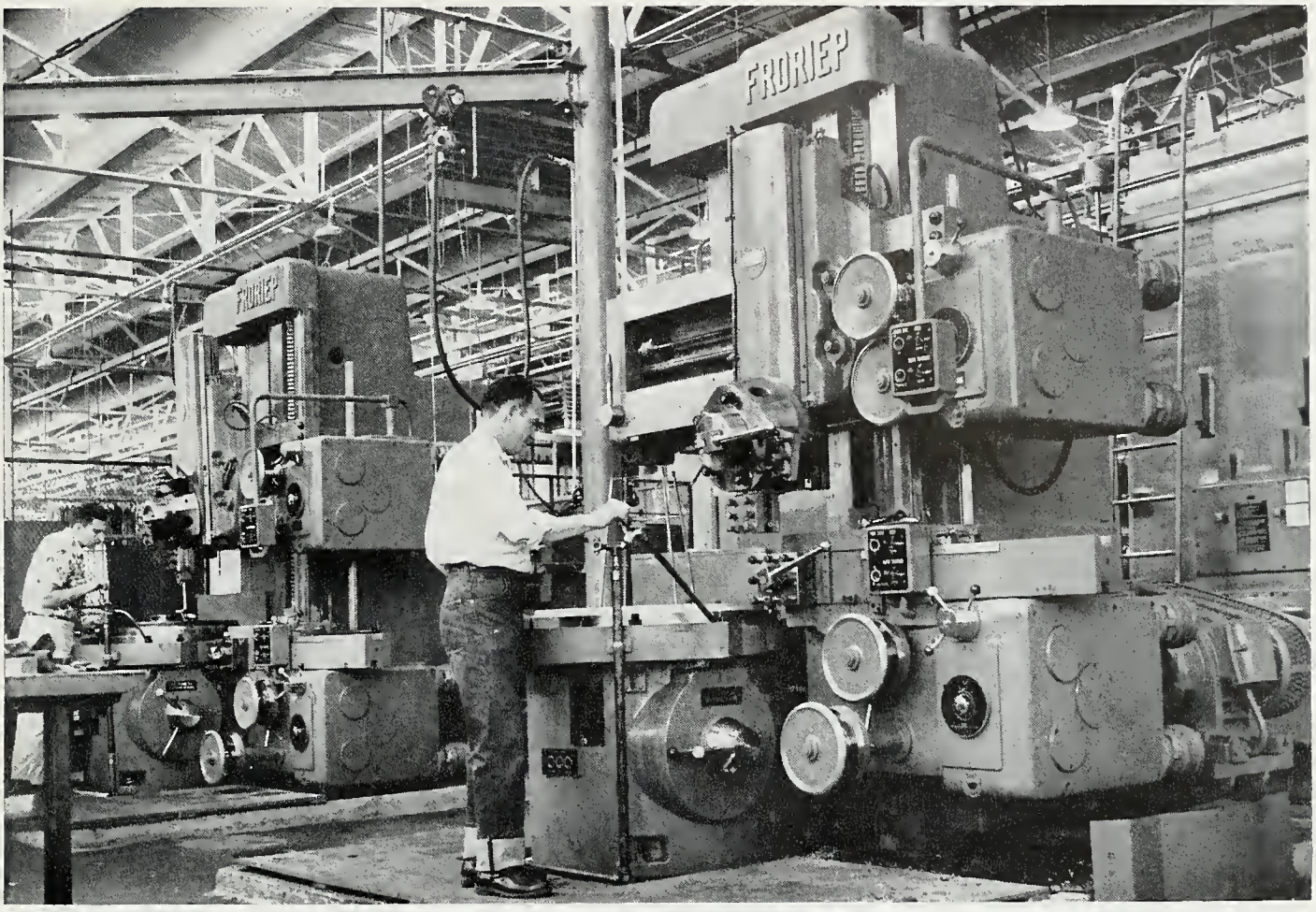
RECENTLY installed, the new machines pictured on these pages point up the versatility of Ryan production. Even within the industry, this versatility is not generally realized.

Some aircraft companies design and build airplanes. Others confine their efforts to production of high-temperature components for aircraft engines. Still others specialize in the development of complex electronics systems. Ryan does all three—and more.

Occupying a unique position, Ryan is probably the only aircraft company which designs and builds: high performance jet aircraft, missiles and drones; high temperature components for turbojets, rockets, ramjets and piston engines; and intricate electronic systems for guidance and control of aircraft.

It is interesting to note that all of these specialized fields — aerodynamics, high temperature metallurgy and electronics— are closely integrated in the production of every modern fighter, bomber or other military aircraft. Nowhere is this better illustrated than in the example of the Ryan Firebee. The Firebee is a swept-wing jet target drone of high performance aerodynamic configuration. It is powered by a high-temperature turbojet engine with a remarkable thrust-to-weight ratio. Control and tracking of the uninhabited Firebee is effected by electronic devices.

SPECIALI



Raymond Mongeau (left) and Harry DeWees operate two new German vertical turret lathes used in machining J-47 and J-57 jet parts.

D AND VERSATILE

Although each field of endeavor is a highly specialized one, Ryan's basic design and production personnel draw benefits from know-how gained in all three. For instance, Ryan's huge external fuel tanks which are built for the Boeing B-47B Stratojet bomber, were designed with the aerodynamic experience accumulated from 31 years of building aircraft.

To successfully fabricate thousands of jet and rocket engine components, Ryan employs know-how gleaned from years of building high temperature exhaust systems plus knowledge which can only come from designing, building and flying jet aircraft.

To design and build entirely new electronics systems for flight applications, Ryan engineers benefit from their first-

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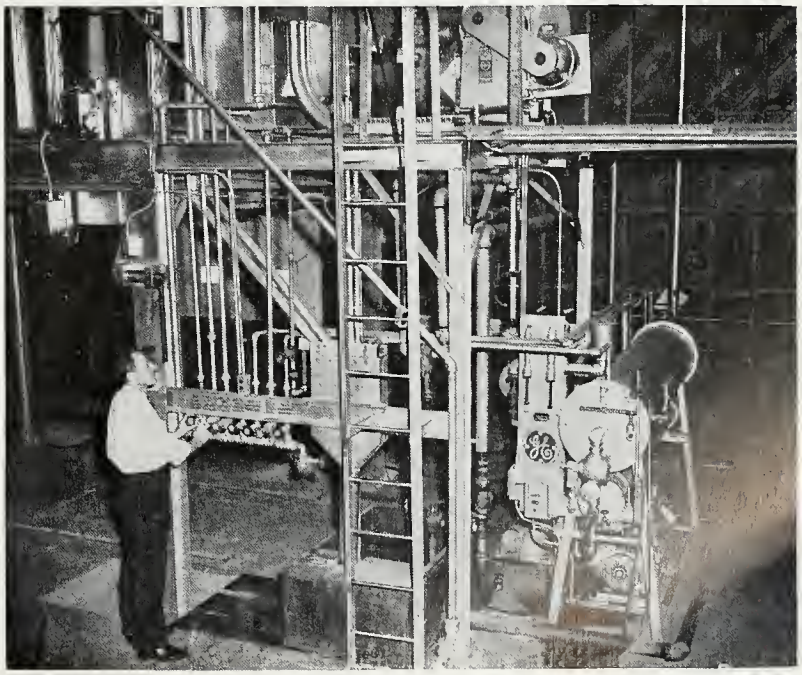
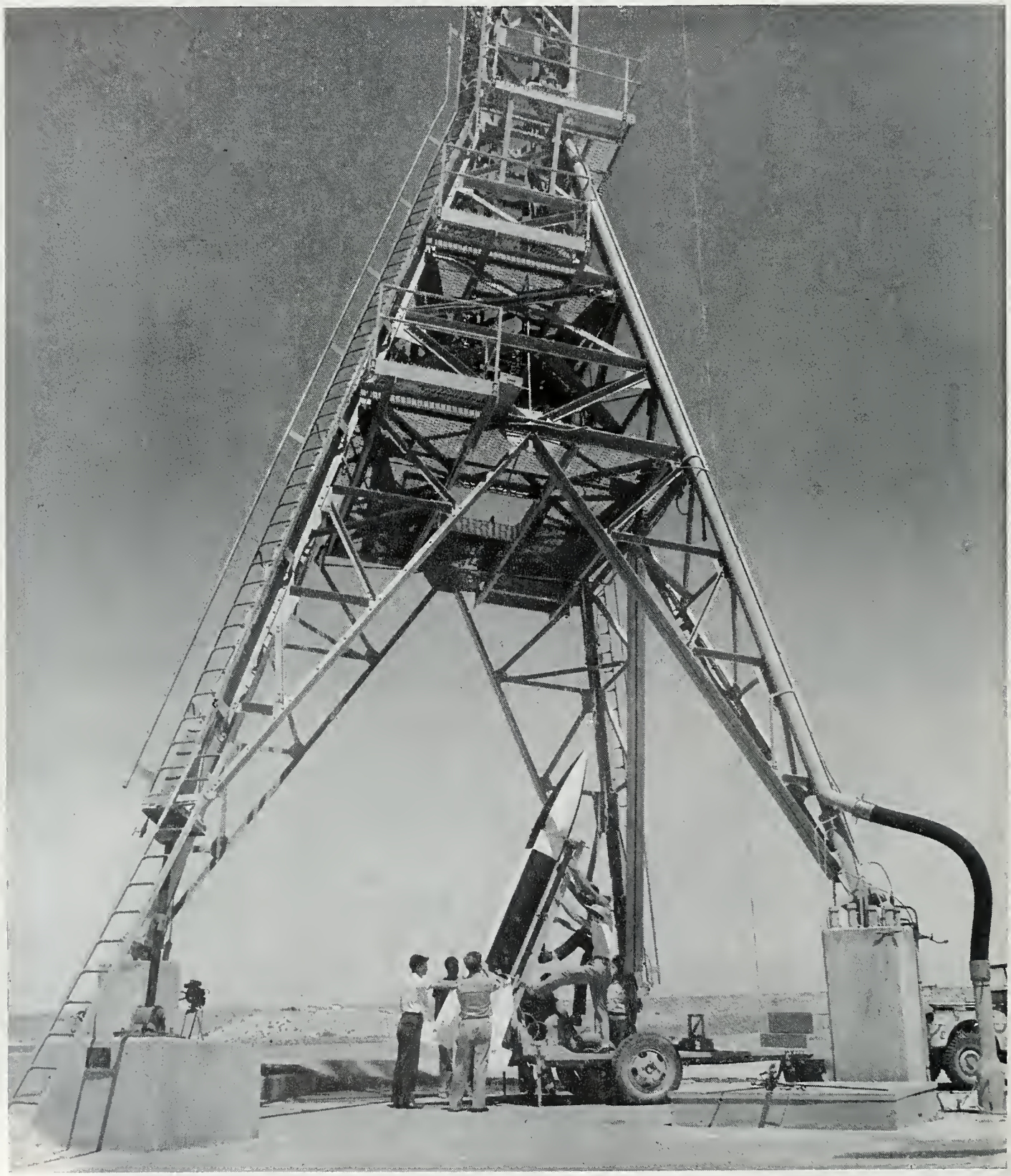


Edward Oberbauer operates controls of Ryan's big G-E electric furnace which is fed a neutral gas from atmosphere converter. It is used to stress relieve Ryan aft frames with precise heat control.

BIRTHPLACE OF THE



A North American NATIV guided missile is placed in giant launching tower at Holloman for supersonic flight to altitude of ten miles.

ATOMIC AGE

Holloman Air Development Center, where the first atom bomb exploded, is locale of guided missile research

MYSTERIES of the upper air and the pushbutton potentialities of electronic control are stock in trade at Holloman Air Development Center, where such new devices as Ryan's spectacular "Firebee," remote-controlled, pilotless jet target drone, are rigorously tested.

Above this isolated, 2,432-square mile expanse of New Mexico desert, near Alamogordo, all types of rockets and guided missiles being developed by the U.S. Air Force's Air Research and Development Command are analyzed in actual flight. Balloons are sent up fantastic distances to obtain data on the upper atmosphere. Electronics research is performed. At Holloman they're dealing strictly with the future.

The Atomic Age was opened at Alamogordo. The world's first atomic bomb was exploded July 16, 1945 in the northwestern corner of what was then the bombing range of Alamogordo Air Force Base, now the missile testing grounds of Holloman ADC.

The base was inactivated after World War II, but not for long. Air Force research and development, rapidly expanding, required a large, unpopulated area for its testing program. In 1947, the Holloman Air Force Base, named for the late Col. George V. Holloman, pioneer in guided missile research, was reactivated. Last October it was re-designated the Holloman Air Development Center. Colonel Don B. Ostrander is commanding officer.

Highly trained crews are assigned to each of the projects. For instance, the "Firebee" performance study is being conducted by Ryan technicians and about 20 Air Force crewmen. Actually, Ryan

(Continued on next page)

Rockets are tracked by both electronic and visual means. Here an instrument with 100-centimeter reflector type lens is trained on the rocket for photographic recording

Ryan "Firebee," pilotless target plane, is recovered in New Mexico desert by parachute drop at conclusion of the drone's test flight.

Pilotless Ryan Firebee is controlled from ground at this station, where instruments are protected by sandbags during ground launching.

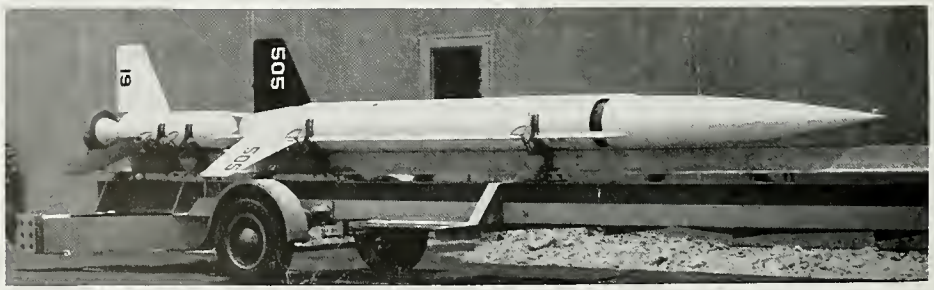
Using new shelter, cameramen from motion picture unit at Holloman ADC film missile activity. The structure provides greater protection and better working conditions.

is no stranger to Holloman. The trail-blazing Ryan "Firebird," air-to-air guided missile, a pioneer project in its field, was tested there soon after World War II and established the foundation for much of the later development of missiles.

Much of the work performed at Holloman ADC is highly secret. Few outsiders have been permitted to witness any of the flights of rockets, guided missiles, pilotless drones, or balloons. But some of the experiments conducted by the scientists, engineers and G.I.'s have become public knowledge.

Aerobee rockets (for which Ryan has built assemblies), have been sent 80 miles straight up at speeds of more than 3500 miles an hour to obtain data on the upper stratosphere, where man has never been but where he hopes to travel some day.

At a predetermined altitude, the rocket



Among guided missiles tested at Holloman ADC is the Aerobee, shown with booster rocket, being towed to launching tower. Aerobee has gone 80 miles high at speed of 3500 mph.

can be exploded, but only after it has automatically dropped its nose cone, containing instruments that give information about a mysterious new realm. The cone is suspended from a parachute, that permits recovery, comparatively undamaged.

The Aerobee also is equipped to transmit data on the upper atmosphere by radio for recording on the ground.

Designed by the Aerojet-General Corporation, Azusa, California, many of the early Aerobees were completely assembled in the Ryan experimental department, where fins, tail cones, nose, nose extension, various shrouds and booster fins were manufactured. Ryan continued to build component parts later, when final assembly was performed elsewhere. The Aerobee is 20 feet long and 15 inches in diameter. The JATO booster adds another 6 feet to the overall length.

Since its initial launching in 1947, the Aerobee has been the most widely used and the least expensive research vehicle of its kind in production. It is powered by a bi-propellant liquid rocket, and is accelerated at the start of its flight by a large JATO booster rocket, which detaches and falls away after the booster thrust.

Helium pressure is applied to the propellant tanks to cause the propellants to flow into the thrust chamber for combustion. After reaching a high velocity during the powered portion of its flight, the Aerobee coasts with decreasing velocities to the peak altitude.

Launching towers, 150 feet high, were built in New Mexico by Aerojet-General, to provide guidance until the velocity is great enough to the fins to give aerodynamic stability. A tilting mechanism in the towers permits compensating for winds.

Where man is not yet ready to soar, monkeys and mice have ventured. Two monkeys and two white mice, secured inside a rocket cone, have been shot forty miles above the earth to determine the biological effects. When the cone was disengaged and dropped by parachute, the high-speed recovery procedure of Holloman ADC went into action. The recovery unit, consisting of small planes and helicopters, quickly located the cone, and within one hour after the rocket was launched, the monkeys and mice were in the Space Biology laboratory, rescued from the heat of the desert.

Soon afterward, they were sent by plane to the aeromedical laboratory at the Wright Air Development Center, Dayton, O., for further study.

Specific data on wind velocity, barometric pressures and other conditions at altitudes of 100,000 feet are obtained by Holloman technicians through use of polyethylene balloons (Project Moby Dick) that carry precise measuring equipment. The military forces must know what their guided missiles and atom bomb-carrying planes may be expected to encounter as they speed through space at tremendous altitudes.

Two key officers in Ryan "Firebee" project at Holloman ADC have been Lt. Wayne Kuncle, left, pilot of F-86 jet chase plane from which running account of target plane performance can be radioed; and Lieut. Bob Schwanhausser, project officer. They are shown at "Firebee" displayed at the base during the observance of Armed Forces Day this year.

Information about winds, temperatures, atmospheric pressures, and types of cloud formations is adding to the body of knowledge needed for accurate weather forecasting, according to Holloman ADC officers.

The polyethylene balloons are only one to three thousandths of an inch thick, 45 to 110 feet in diameter and up to

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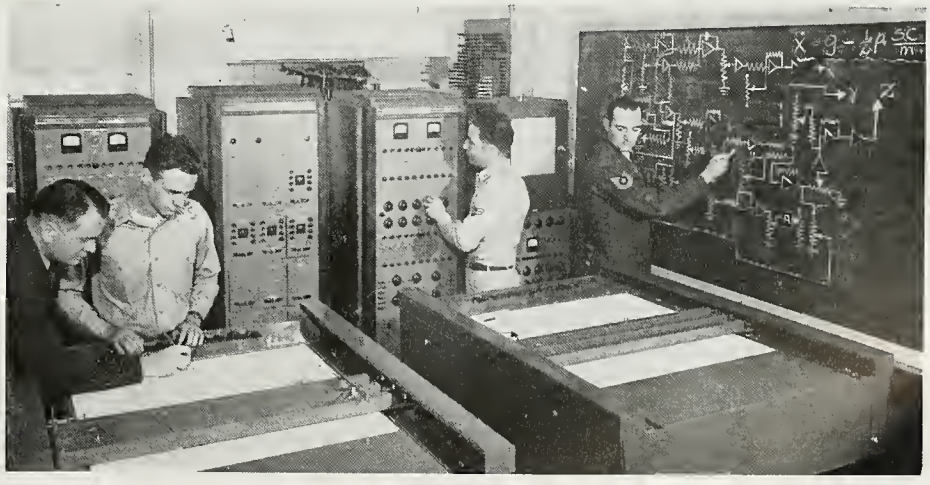
Lts. J. L. Hartman and J. D. Telfer introduce their world famous mice which made flight into upper atmosphere with no ill effects.



Test performances at Holloman are analyzed by electronic "brains," such as this analog computer, which solves problems by substituting electrical for mechanical quantities.

Known as the "sanctum sanctorum," this carefully guarded electronic research room is where Ryan's top engineers develop the robot brains which supplant pilots in uninhabited aircraft. Complex instruments are needed to check the navigational devices "intelligence."

RYAN AT WORK ON NAVY AIRBORNE ELECTRONIC EQUIPMENT

Work is now under way at Ryan Aeronautical Company on a new contract received last fall from the Navy Bureau of Aeronautics for airborne electronic equipment, T. Claude Ryan, president, announced recently with Department of Defense approval.

The contract with the Airborne Equipment Division of the Bureau of Aeronautics is for improved models of electronic navigational devices Ryan has been developing for the past three years. The new units, according to Owen S. Olds, head of Ryan's electronic section, are lighter and more compact than the earlier prototype model which has been installed in the Navy P2V Neptune bomber on loan from the Navy, and is now being flight tested by Ryan engineers and technicians.

The Ryan-developed electronic navigational equipment has wide applications in other fields, but specific identification of its present or potential uses has not been permitted.

The new contract more than doubles the dollar value of orders placed by the Navy for Ryan electronic equipment. Additionally the company announced last month that it had received new contracts from the Air Force for electronic components for guidance systems Ryan is developing.

Ryan's interest in the field of electronic components for navigational equipment and guidance systems is an outgrowth of work of this general nature done in connection with development of the Ryan "Firebird" air-to-air guided missile. While the "Firebird" was purely a research missile and was not placed in production, the electronic principles investigated at that time have since been refined by Ryan technicians.

TIME TELESCOPED

Douglas DC-6B airliner and "go-anywhere, do-anything" B-47B Stratojets set trans-Atlantic records

TIME has been telescoped, space has been squeezed in spectacular performances by two types of Ryan-equipped American planes—one a commercial transport, the other a medium bomber.

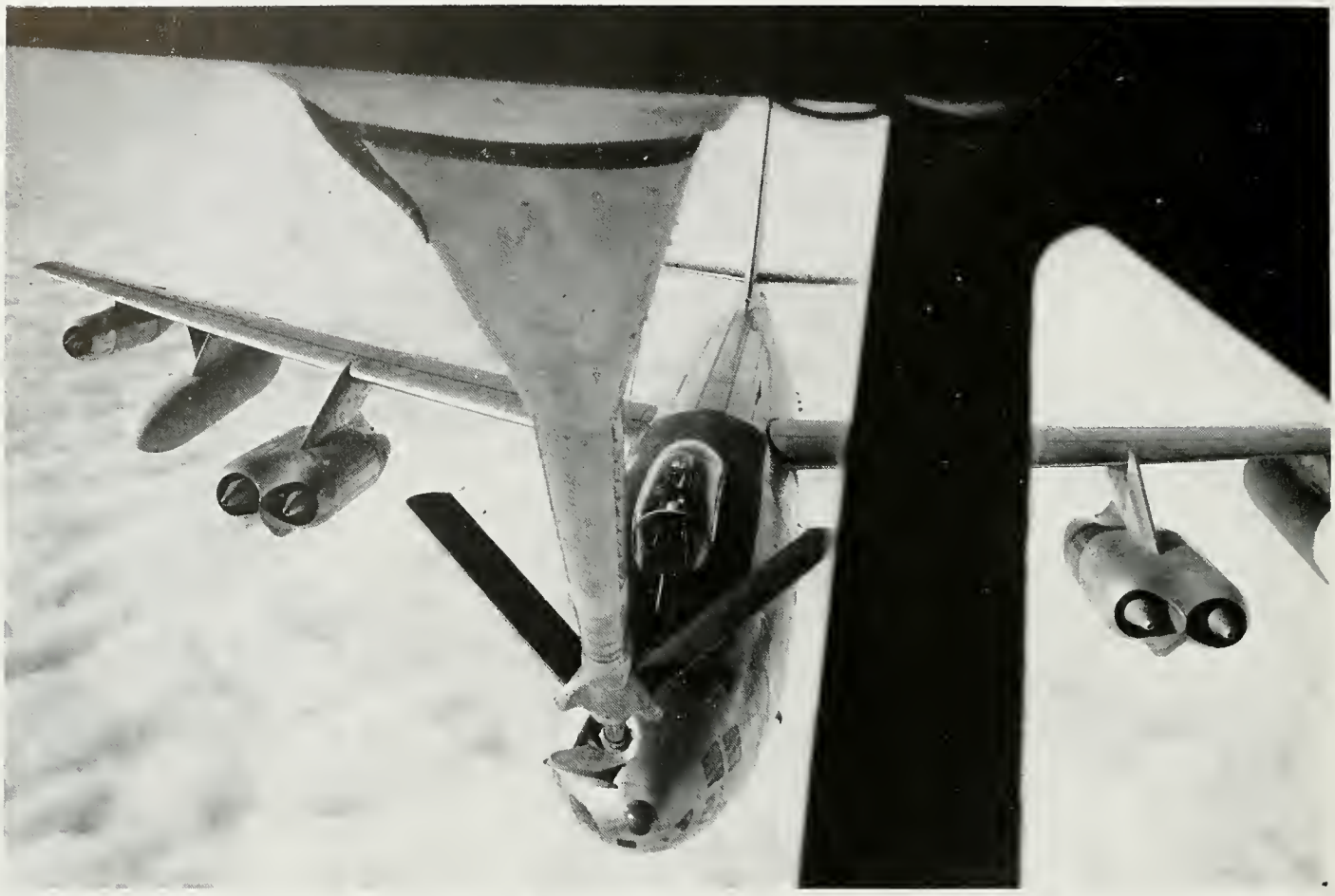
A Douglas DC-6B airliner, for which Ryan produced the exhaust system, has to its credit the longest non-stop flight ever made by a commercial aircraft. Last Memorial Day weekend, this giant of the airways, on a normally scheduled delivery trip from the plant in Santa Monica to the Paris headquarters of Transport Aeriens Intercontinentaux, flew the 5,700 miles non-stop in 20 hours, 28 minutes.

And, on June 5, a B-47 six-jet, swept wing bomber of the 306th Medium Bombardment Wing, made the fastest trip across the Atlantic in aviation history. It compressed the distance between Limestone Air Force Base, Maine, and the Fairford, England, Royal Air Force Base—3,120 miles—in 5 hours, 22 minutes.

To Ryan Aeronautical Company employees, this flight took on added significance because of the tailpipes they produce for the B-47 bombers, and the jet engine components for the General Electric J-47s that furnish the power. Ryan also

(Continued on next page)

This Douglas DC-6B airliner set world's distance record for commercial transports by flying 5700 miles from Santa Monica to Paris.



Boeing B-47 bomber, of type shown being refueled in mid-air, holds trans-Atlantic speed record in hop made without need of refueling.

B-47 bomber tail pipes, on which production is being accelerated at Ryan Aeronautical Company in new conveyor assembly line, are shown prepared for shipment.

makes the world's largest external wing fuel tanks for the B-47. In this crossing, however, the tanks were not used.

When the Douglas DC-6B touched down at Paris, it still had 816 gallons of its original 6,755 gallons of fuel, enough for two more hours of flight after having established a world's distance record for commercial airliners. Although sponsors of record attempts generally wait for the most favorable weather, the DC-6B took off on the normal scheduled delivery date. The favorable tailwinds across the North American continent were nullified by strong headwinds generated by a storm over Labrador. The plane, second of three ordered by T.A.I. for operations between Paris, Madagascar and French Indo-China, has a top speed of 360 miles per hour and cruises at 315 miles per hour. Its record eclipsed the previous non-stop mark for commercial planes, set last January by another DC-6B, flown by Scandinavian Airlines System over a 4,000-mile route between New York and Stockholm.

The trans-Atlantic flight of the B-47 also was strictly an operational hop, not arranged primarily as an assault on records. The bomber, piloted by Capt. James B. Carter, was

one of 45 in the 306th Medium Bombardment Wing, battle-loaded with dummy atom bombs, being transferred from their regular station at MacDill AFB, Florida, to England via Limestone AFB, Maine, for a 90-day training mission over Britain and the continent.

The wing, only all-jet combat-ready bomber unit of its type in the U.S. Air Force, is commanded by Col Michael McCoy, who only last April flew a B-47 to Britain in a record 5 hours, 38 minutes.

That mark was cracked by six planes in the 45-bomber flight to Fairford in June. One did it in 5 hours, 37 minutes; two in 5 hours, 36 minutes; one in 5 hours, 30 minutes; one in 5 hours, 29 minutes; and finally, in the third and final echelon of the wing, divided into three 15-plane groups, came Capt. Carter's B-47 that demolished all other records with its 5 hour, 22-minute flight.

Not only were speed marks set, but the mass transfer of B-47s was the first movement of an Air Force jet bomber wing across the Atlantic. Units of the SAC have rotated to advance bases overseas for temporary training periods since 1948, but the B-47s are the first all-jets in Britain, where they are occasioning widespread interest.

Although mid-air refueling was not necessary on this flight, 20 Boeing KC-97 Stratotankers, for which Ryan builds the aft fuselage sections and the refueling pods, and makes the exhaust systems, accompanied the B-47s to England, where they will train with the jets.

Able to carry an atomic bomb faster and higher than any other aircraft in its class, the B-47 will eventually become the mainstay of the SAC. The 306th Bomb Wing has been converting from B-29 Superforts to B-47 Stratojets since October, 1950.

Brig. Gen. Henry K. Mooney, whose Sixth Air Division operates both the 305th and 306th Bomb Wings, has asserted that the B-47 answers the Air Force's requirement for aircraft compatible with the times, adapted to greater speed and higher altitudes.

As a speedy bomber with a medium range that can be extended by use of the Ryan external wing fuel tanks and

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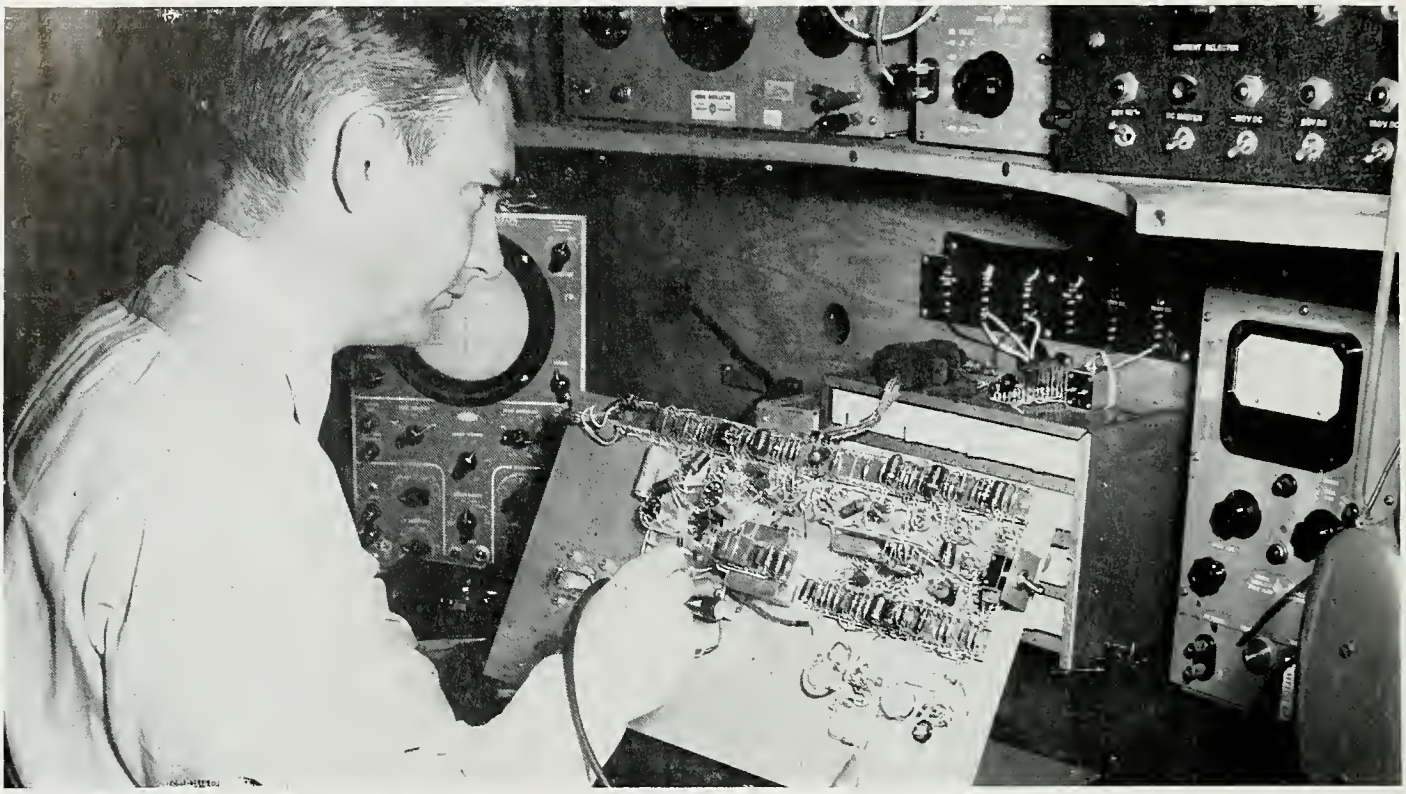
Against silhouetted pilot, swept-wing B-47, which can carry atom bomb faster and higher than any medium bomber, is depicted in flight.



ELECTRONICS— Surrounded by a maze of intricate equipment, an electronics engineer checks electrical circuitory on a "bread-board" to establish their overall functioning before the required degree of subminiaturization is achieved.

R & D . . .

JET ENGINE RESEARCH— Rear Admiral J. B. Moss (center) Ass't BuAer Chief, Navy Captain Cedric Stirling and Commander F. E. Rogozienski are given preview of research project at Ryan jet test cell by President T. Claude Ryan (left) and Ryan Executive Engineer Immenschuh.

RESEARCH has been defined as the effort to understand relationships which no one has previously known. If this is true, aviation has contributed heavily to this exploration. No other realm of endeavor has overlapped the boundary between the known and the unknown in so many fields of science. Aerodynamics, electronics, metallurgy, thermodynamics, medicine, chemistry, astronomy and others have disclosed new relationships under aviation's pressing quest.

Airplanes are flying twice as fast and twice as high as in World War II. The sonic barrier has been breached and the thermal barrier looms in the future with the problem of how to keep the pilot from "simmering like a beef stew" in 2000-miles-per-hour planes getting serious consideration from design engineers.

Ryan research started a long time ago

as aircraft development is measured. Perhaps it began when Claude Ryan bought a Douglas Cloudster airplane in 1925 and converted it from an eight-passenger, open-cockpit affair into a ten-passenger cabin plane. Certainly, as a basic idea, this was a forerunner of the modern airliner. Or maybe it was when Ryan pioneered the use of low-wing monoplanes, delivering the first that the U.S. Army every used for primary pilot training, in 1939. In any event, Ryan has always placed emphasis upon research and development and has hung up an impressive record of aeronautical "firsts" in the process.

Unfortunately, the most interesting and dramatic projects which currently fall within the scope of Ryan research and development are necessarily restricted by the requirements of military secrecy. In this category, Ryan engineers are working on unique and challenging ideas which could change many present concepts.

To even a casual observer it must be evident that electronic devices play a key role in modern aircraft and, consequently, in much of the engineering work which Ryan performs. In the creation of both the Ryan Firebird missile and the Ryan Firebee target plane, highly sensitive electronic systems have been a corollary development necessary to the success of the projects. This is a confidential field which is assuming increasing importance as uninhabited aircraft become more

FIREBEE— Latest product of creative Ryan engineering and manufacturing is this newest high-speed, high-altitude, jet-powered target plane.

Research and Development . . . the Blueprint of Tomorrow

prevalent. More and more, the electronic "brain" is being called upon to make the "decisions" which were formerly a pilot's function.

Ryan occupies a leading position in the production of tiny electronic and radar devices, often no bigger than a package of cigarettes, which can "think" in the body of a whizzing missile. Consisting of miniature tubes, transistors and other dwarfed components, these "brains" must be crammed into amazingly small spaces and capable of operating at high temperatures. In an uncanny way, they receive thousands of "messages" per second, "analyze" this information and "pilot" the missile on its streak through space.

For flight evaluation of electronic and radar systems, Ryan engineers have a fleet of three aircraft at their disposal. Indicating the importance of the work to the Armed Forces, a Navy Lockheed twin-engined P2V Neptune and an Air Force North American F-86 Sabrejet fighter have been loaned to Ryan for in-flight testing. A Ryan Navion comprises the third plane of this team. Because of the far-reaching effect of electronic advances, each development that Ryan accomplishes may have innumerable application in many other companies and industries.

In 1946 Ryan designed and built a jet test cell which is equipped to test the most powerful jet engines and afterburners. Constructed of 18-inch thick concrete and steel armor plate, the massive vault contains a heavily "fortified" control room for observers. Through a glass-covered slot, Ryan engineers can watch the behavior of earth-bound jet engines as they blast a turbulent wake of

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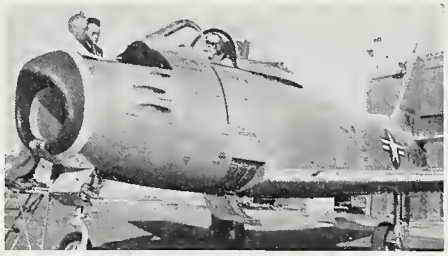


F-86— Ryan uses F-86 Sabrejet fighter to test new electronic devices.

P2V— Navy P2V Neptune is also loaned to Ryan for in-flight research.

flames and heat. The test cell serves a dual function in evaluating both new designs and metals.

In 1949, Ryan announced completion of an important pioneering project—successful research on the first air-to-air guided missile for the Air Force. The result of more than two years flight testing, this 10-foot-long, rocket-propelled projectile was virtually a fragmentation shell endowed with human "intelligence." Designated the Ryan XAAM-A-1 "Firebird" it was designed to track enemy aircraft by means of complex radar navigation and electronic systems.

In operation the Firebird was launched from a high speed "mother" plane and

TURBO-PROP—Navy's first turbo - prop was Ryan's XF2R-1 shown with with propeller feathered. This model Fireball pioneered use of propeller as brake to speed descent.

set to "home" on its air borne target. It was fired by a self-contained booster rocket in its tail; then, when maximum speed was attained, the booster rocket was jettisoned and a series of flight rockets sped the missile to its tracked target.

Wings and tail of the Firebird were in the form of a double cruciform, the wings have an X attitude and the fins a + attitude when in level flight. The four vanelike wings, of about 3-foot span, were located midway on the projectile. Two feet behind were the four tail vanes. Both wings and tail surfaces served to control flight of the missile.

Working with Air Force technical personnel, Ryan engineers conducted extensive Firebird firings at the testing range at Alamogordo, New Mexico. North American F-82 and Douglas B-26 planes were used as launching platforms. From these experiments the Air Force and aircraft industry gathered valuable design data which was used in the improvement of air-to-air missiles. Ryan's present electronic projects are an extension of work originally done on the Firebird.

Shortly after completion of the Firebird project, Ryan developed detail plans for another pilotless aircraft—a high speed jet propelled target plane. After a major competition, Ryan was awarded a contract to build the Firebee target drone and is continuing its development at this time.

In retrospect, the Ryan FR-1 Fireball Navy fighter is one of the most striking evidences of Ryan aggressiveness in tackling jobs never done before. In fact it was labeled a "can't be done" project by some aeronautical authorities when it was first conceived by Ryan and Navy engineers.

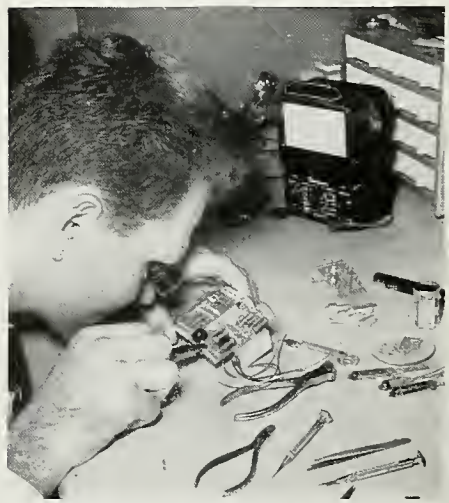
In 1943, jet propulsion was a nebulous phrase cloaked in military secrecy. Three months before, the first American jet plane had flown and the Navy wanted to adapt the promising, new form of propulsion to carrier operation. But, because the engines developed little thrust at low speeds, it was impossible to take a jet plane off a carrier deck with engines of that period.

Navy and Ryan engineers conceived the idea of building a carrier plane which would combine the advantages of both piston engine and jet power plant in a single configuration. The conventional engine and propeller would be used for cruising and for low-speed operations including take-off and landing. The jet would be switched on for high-speed performance, especially in combat maneuvers.

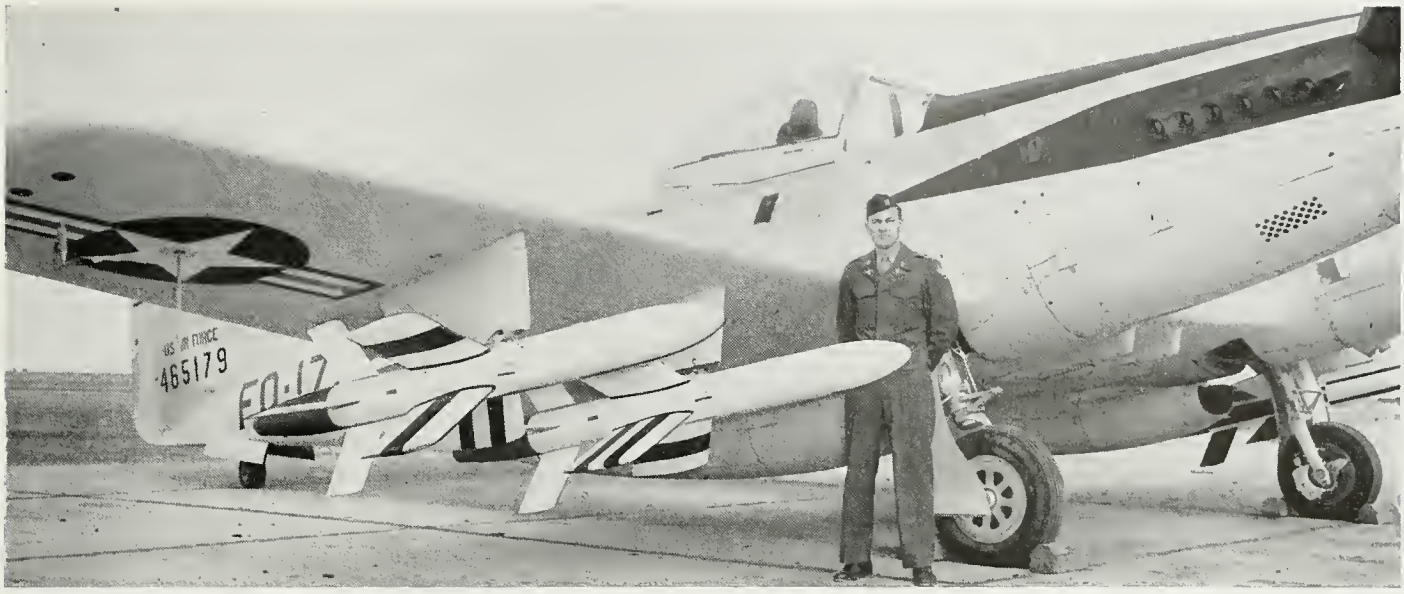
This was an ambitious undertaking because the plane would have to meet all of the requirements of a carrier-based aircraft and contain the equipment and facilities for operating two basically different engines in a light-weight design. Also, no one knew what problems would be encountered when these two types of power plants were teamed together.

Ryan started to work on the revolutionary idea and the result was crystallized in 1944 in the form of the world's first composite-engined aircraft. Undoubtedly, one of the most pioneering designs ever attempted, the Fireball broke many precedents. With the gear for two engines and a Navy fighter pilot packed within its 10,000-pound contour, it was probably the most compact plane built.

Because it was the Navy's first jet-



SUBMINIATURIZATION—Carlos Johnson uses jeweler's tools and magnifying glass to wire typical packaged subminiature circuit developed by Ryan electronics engineers.



FIREBIRDS— Slung under the wing of a North American F-82 "mother plane," two Firebird missiles await take-off time at Alamogordo, New Mexico, rocket testing range. Special parachutes recover the test missiles, undamaged.

propelled plane, the Fireball pioneered the use of jet aircraft on carriers. Of almost equal importance, it was the first tricycle-geared aircraft qualified for carrier operations. This type of gear, now a familiar sight on carrier decks, gave the Fireball improved dynamic stability and kept the searing jet blast off the deck. Careful engineering and research were required to evolve successful arresting and catapulting gear and techniques for this entirely new design.

To enable Navy pilots to fly efficiently on the jet engine alone, the Fireball was equipped with the first full-feathering propeller used on single piston-engined aircraft. Previously used only as an emergency measure on multi-engined aircraft, this propeller could be feathered to head the blade edges into the air flow.

Many new manufacturing techniques

(Continued on Page 29)

FR-1— Problem: Combine two types of power plants in one plane. Result: The Fireball was the world's first composite-engined aircraft and Navy's first jet aircraft.

TRICYCLE GEAR ON CARRIER— All eyes are glued on Ryan FR-1 Fireball as the sleek jet fighter is cable-arrested aboard a carrier. The Fireball pioneered use of tricycle-geared planes on carriers.

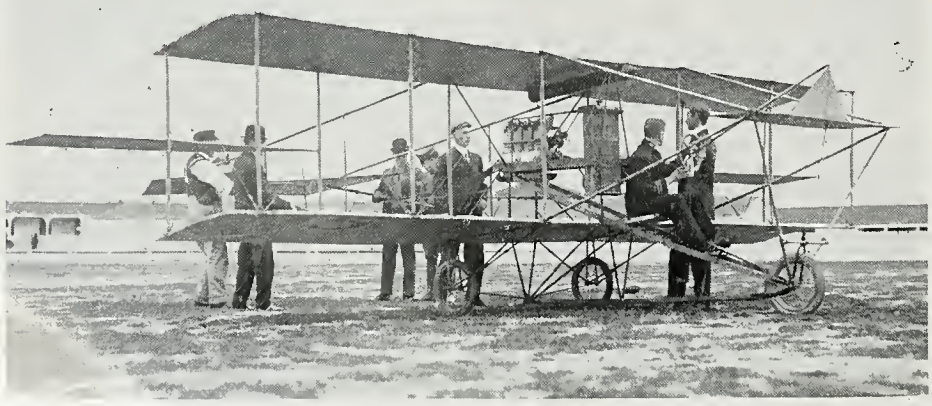
Library of Congress

1903 The era of powered flight began Dec. 17, 1903, when Orville Wright made the first sustained takeoff in an airplane near Kitty Hawk, N. C. This photo, recently released by the Library of Congress, was made by a camera set up by Orville Wright and snapped by John T. Daniels. Wilbur Wright is shown running beside the plane.

FIVE DECADES OF FLIGHT

After only a half century of powered flight, man looks beyond the earth

1913 Much of the aviation pioneering done by Glenn Curtiss was performed in San Diego at what is now North Island. By 1913, the Army Signal Corps had received the first of its airplanes ordered in a contract with Curtiss.



From Union Title Insurance & Title Co. Collection

1923 The first non-stop flight across t and Oakley Kelly in Fokker mon was starting commercial operatio

Wide World Photo

U.S. Air Force

1953 **In five decades man not only has learned to fly faster than sound but has devised means of flying without a pilot. Typical is Ryan Aeronautical Company's spectacular "Firebee," remote-controlled, jet target plane shown here as it is released from its "mother plane" in a test flight over New Mexico desert at Holloman ADC.**

FROM Orville and Wilbur Wright's muslin-and-wood powered "boxkite" to today's guided missile, supersonic jet, or remote-controlled pilotless planes, only a half century has elapsed.

But this moment in recorded time has rightly been described as the most fantastic in history. Just 50 years after the start of tortuous experiments which finally enabled man to lift himself in controlled flight, he is already looking beyond the earth, to the creation of space stations that would circle the earth, to space ships that would make interplanetary commuters of us.

In half a century from the first sustained controlled flight, of 852 feet in 59 seconds at Kitty Hawk, aerial vehicles have been developed that can streak 80 miles high at speeds of more than 3500 miles an hour.

Constant experimentation is a way of life in the aviation industry. Every major aircraft manufacturer is peering into the future, constantly crossing new frontiers of knowledge. The miracles of yester-

(Continued on Page 26)

ted States was performed by Lieut. John Macready lower left, about the same time T. Claude Ryan an Diego in war-surplus plane, shown lower right.

1933 **When Wiley Post was circling the world in his famous plane, "Winnie Mae," another clean-line aircraft, the Ryan ST, lower right, was making its debut as forerunner of many noted sports planes and military trainers.**

Wide World Photo

ORGANIC AVIATION in the ARMY

by Major General Paul W. Rutledge, USA
Assistant Chief of Staff for Development and Test
Army Field Forces

The helicopter has given Army assault troops new mobility. Unloading is so rapid, it is not necessary for the "chopper" to touch down.

Ryan Navion L-17 liaison plane comes in for a landing at an airstrip somewhere in Korea after a fighter-direction mission.

"The Army is adopting aircraft as it adopted the motor vehicle not so many years ago."

THE Army's aviation program had its beginnings in the Louisiana maneuvers in 1941. These maneuvers marked the first use of small airplanes as organic equipment with ground units.

It is of particular interest to note that the aircraft used by the Army were owned and operated by aircraft manufacturers and not by the Army. They were used in the maneuvers as a result of the efforts of a few artillery officers and representatives of industry, and proved fully that a light plane under complete control of the ground commander provided more and better observation over the battlefield than had ever been available by other means.

It is with full awareness therefore, of the vital and indispensable role played by industry, in the development of Army aviation from its very inception, that I propose to sketch for you, the progress that it has made, and to give you a view of the valuable and effective combat implement that Army aviation has become.

The growth of Army aviation during World War II was very rapid, and related directly to the growing recognition of its outstanding value. Initially the opinion was held by many, that the light airplane was a "sitting duck" and could not survive in the air over the battlefield. Early experience soon dispelled this idea, when it was found that the speed differential and the extreme maneuverability of the small airplane made it a difficult

and dangerous target for high speed fighters. Its ability to quickly return anti-aircraft fire with directed artillery fire gave it a measure of defense against this threat.

From approximately forty planes and pilots during the Tunisian campaign, Army aviation expanded to approximately four thousand by the end of World War II. Where aircraft were at first assigned only to artillery units for adjustment of fire, their value was quickly recognized by the Signal Corps, Corps of Engineers, Infantry, Armor, and Service units.

The types as well as the numbers of aircraft required by the Army increased as the mission requirements grew. The first helicopters obtained by the Army were procured in 1947. These were followed by a procurement quantity of 65 Bell helicopters in 1948. This represented the largest procurement of helicopters by any agency up to that time.

To illustrate the growth of Army aviation since World War II, I offer these comparative figures. A typical field Army in 1945 had approximately 240 aircraft of one type assigned to it. This figure is now closer to nine hundred aircraft per field Army, including six different types.

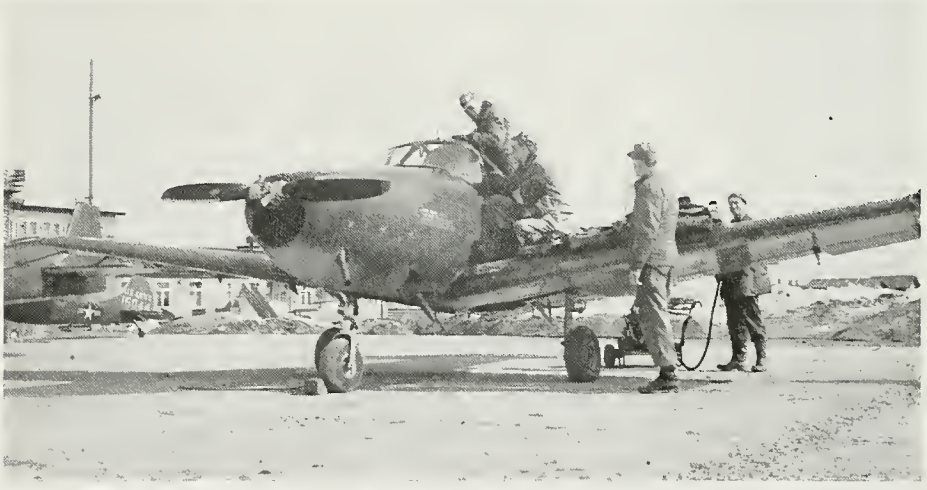
The Army's organization for employment of aircraft is unique among the Services. Whereas the Air Force and Navy aircraft are organized into squadrons, wings, groups and larger units, the great bulk of the aircraft used in the Army is organic to its tactical or service units. The principle of its employment from the very first has been that of closest support to and control by the ground units. Since there is no more complete control than outright ownership, the airplane is therefore issued directly to the unit which needs it.

For example, the Infantry Division is authorized twenty-six aircraft. These aircraft are not organized into a squadron, or other type unit to support the Division but rather are distributed down to regimental and battalion level according to Table of Organization and Equipment, with the exception of a small group of aircraft at Division Headquarters. Thus the small unit tactical commander has aircraft under his immediate control for observation, adjustment of fire, reconnaissance, limited medical evacuation, aerial

(Continued on Page 24)

U.S. ARMY PHOTOGRAPHS

Wire construction officers of a signal company in Korea check wire laying equipment mounted on Army L-19 "Bird Dog."



"Off-the-shelf" commercial planes like Ryan Navion are widely used for transport as well as combat missions. This L-17 is used by Headquarters, U. S. Forces in Austria.

At a U. S. Tenth Corps airstrip on the central front in Korea, an L-19 unloads mail for United Nations troops fighting in the front lines.

1953

"33 HOURS TO PARIS"

Lindbergh tells of the building of his Ryan monoplane for Trans-Atlantic flight

TWENTY-SIX years ago, an "obscure manufacturer" in an "old dilapidated building near the San Diego waterfront" had the colossal confidence it could build a plane capable of flying nonstop between New York and Paris.

It was a company "new and small and not well known," but a St. Louis airline pilot named Charles A. Lindbergh, obsessed with a passion to fly the Atlantic, was just about at the end of his resources, and time threatened to defeat him if he didn't get a plane soon. Virtually all the major, well established manufacturers either wanted too much money, put strings on any tieup with Lindbergh, or had design ideas that didn't jibe with his.

And it was getting late. Some of the world's greatest fliers, men like Chamberlin, Byrd, Fonck, were almost all set for the New York to Paris flight and the $25,000 Orteig prize. They had reputations and ample financial backing; he was unknown and had a shoestring.

Contacting Ryan Airlines in San Diego was almost an act of desperation by a sorely frustrated young man. Lindbergh recalls his decision vividly in his dramatic book, "33 Hours to Paris," which millions of Americans read in the Saturday Evening Post ten-part condensation last spring. The entire story will be told in the book due for release by Scribner's in September.

On the airmail run between St. Louis

LINDBERGH: "I've read of a monoplane with unusually good performance, built by a company named Ryan, out in San Diego. . . . Some of them carry mail on the West Coast."

Pioneer west coast air mail route, San Diego to Seattle, was surveyed by T. Claude Ryan for Pacific Air Transport. Ryan, left, and his partner, B. F. Mahoney, right, confer with Vern C. Gorst, P.A.T. president, before trail-blazing flight in M-1, forerunner of "Spirit of St. Louis."

Lindbergh's own book, "The Spirit of St. Louis," will be published this fall by Charles Scribner's Sons. A condensation under the title "33 Hours to Poris" hos been appearing in The Saturday Evening Post.

and Chicago late in 1926, the vision gripped Lindbergh. He had seen the new Wright-Bellanca, which had taken off with phenomenal weights on some of its test flights. Why couldn't he try to fly the ocean in a Wright-Bellanca, powered with a Wright Whirlwind engine, far more reliable than the old Liberties?

The first requirement, of course, was money. He had $2,000 of his own. A Bellanca would cost ten to fifteen thousand dollars. Could he interest St. Louis businessmen in backing him? The very first one he approaches expresses interest, but is amazed at Lindbergh's flight plan. He is the first of many whose scepticism Lindbergh must combat until he encounters Ryan Airlines.

For very practical reasons, and not for heroics, Lindbergh has decided that the flight must be in a landplane with only one engine, and with no co-pilot or navigator. The weight must be kept down. A flying boat couldn't take off with enough fuel. A three-engine plane, such as the Fokker being prepared by Commander Byrd for the flight, would provide no greater safety than a single-engine plane, Lindbergh believes. If one engine stopped over the ocean the other two would be unable to get it back to land. And with three engines, the chances of failure were three times that for only one engine.

And of course, these big planes cost a lot of money. Lindbergh inquired of a Fokker salesman. Ninety thousand dollars!

The strings begin encircling Lindbergh. The Fokker company, he was told, wouldn't even consider selling him a plane if it wasn't satisfied with his competency.

Would Fokker be interested in building a single-engined plane? Definitely not!

Lindbergh's first financial supporter is Maj. Albert Bond Lambert, a longtime Midwest aviation leader, for whom Lambert Field in St. Louis is named. Lambert pledges $1,000. Then Lindbergh's airmail boss, Maj. Bill Robertson, suggests that perhaps the St. Louis Post-Dispatch would be interested in backing the venture if its name were painted on the fuselage.

This doesn't appeal to Lindbergh's essential non-demonstrative nature, but he goes to see one of the Post-Dispatch editors anyway. The rejection is polite but firm.

"The Post-Dispatch wouldn't think of taking part in such a hazardous flight," says the editor. "To fly across the Atlantic Ocean with one pilot and a single-engine plane! We have our reputation to con-

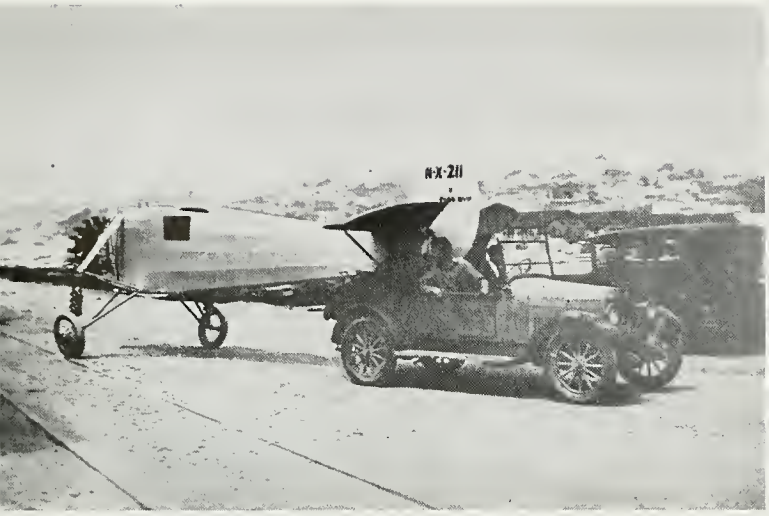
(Continued on next page)

FLIGHT LOG
Spirit of St. Louis

Date 1927	Flight	Time
April 28	Dutch Flats, San Diego, California	
	First test flight	0 hrs. 20 min.
	Second test flight	0 hrs. 05 min.
April 29	Dutch Flats	
	Three test flights	0 hrs. 20 min.
May 3	Dutch Flats	
	One test flight carrying Donald A. Hall (Designing Engineer)	0 hrs. 10 min.
	One flight, carrying Major Erickson (Photographer)	0 hrs. 10 min.
	One flight, for photographs from other plane	0 hrs. 15 min.
May 4	Dutch Flats to Rockwell Field, North Island (Landed because of fog, at 5:50 a.m.)	0 hrs. 10 min.
	Rockwell Field to Dutch Flats	0 hrs. 05 min.
	Dutch Flats to Coronado Strand speed course to Camp Kearney parade grounds (Tests)	1 hr. 10 min.
	Three test flights, starting with 38 gallons of gasoline	0 hrs. 10 min.
	One test flight, with 71 gallons	0 hrs. 15 min.
	One test flight, with 110 gallons	0 hrs. 05 min.
	One test flight, with 150 gallons	0 hrs. 05 min.
	One test flight, with 200 gallons	0 hrs. 10 min.
	One test flight, with 250 gallons	0 hrs. 05 min.
	One test flight, with 300 gallons	0 hrs. 15 min.
May 5	Camp Kearney parade grounds to Dutch Flats, carrying Major Erickson	0 hrs. 05 min.
	Dutch Flats to North Island, carrying A. J. Edwards (Sales Manager)	0 hrs. 10 min.
	North Island to Dutch Flats, carrying A. J. Edwards	
	Total flying time 4 hrs. 15 min. Total flights 23	
May 10	Dutch Flats to North Island, carrying Mr. McNeal (Final Assembly Department)	0 hrs. 05 min.

LINDBERGH: "We need checks on gasoline consumption, but I'll save time by doing that on my flight between San Diego and St. Louis."

Minutes before taking off from San Diego for St. Louis, Lindbergh posed for this historic photo. John van der Linde, now Ryan production manager, is shown atop plane, fueling it through funnel. Others are, left to right, O. R. McNeel, then welding foreman, now an Oregon building inspector; George Hammond, then student mechanic-pilot, now living in Santa Barbara; Lindbergh; Donald Hall, then chief engineer, now engineer at San Diego Naval Air Station; and the late A. J. Edwards, who was then sales manager of the company.



LINDBERGH: "The fuselage went through the factory doorway easily enough, but the forty-six-foot wing in the loft created a problem. For a time it looked as though we'd have to tear out a section of the wall, but we managed by tipping the wing at an angle and removing the loft's double doors."

From the factory in an abandoned fish cannery, the "Spirit of St. Louis" was moved in sections to Dutch Flats for final assembly.

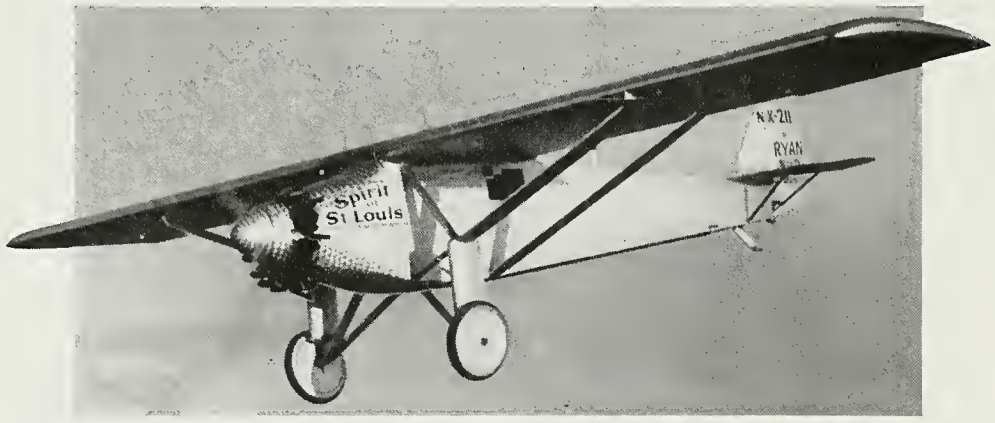


Photo by H. A. Erickson

LINDBERGH: "I spiral cautiously up to 2000 feet and head across San Diego Bay."

On the test flights, Lindbergh becomes accustomed to plane's comparative lack of stability, which was intentionally sacrificed for range by designing small tail surfaces.

LINDBERGH: "We fill the center wing tank for our first heavy-load test. After that will add fifty gallons of gasoline for each succeeding take-off." . . .

After the 300-gallon test, Lindbergh decided to forego increased load takeoffs. He was eager to start his adventure, and on May 10, 1927, "Spirit of St. Louis" left San Diego.

LINDBERGH: "I'm going to test The Spirit of St. Louis this morning. It's the twenty-eighth of April, exactly sixty days since work on the plane began."

On the Ryan Flying Company field, Dutch Flats, San Diego, final assembly was completed, and Lindbergh is ready for intensive testing.

sider. We couldn't possibly be associated with such a venture."

Then, on his own, Lindbergh invests $5 in a long-distance phone call to Wright Aeronautical Corp., Paterson, N.J. That, he felt, would be the most impressive way to gaining an audience with one of the top executives. Sure enough, he obtains an appointment to talk over the possibility of getting the Wright-Bellanca.

The Wright-Bellanca was built, he was told, only to show how a Whirlwind can perform in a modern plane. Wright was negotiating to sell the plane and manufacturing rights to the Huff-Daland Company. And besides, didn't Lindbergh think that a three-engine ship would be better for a flight across the Atlantic?

The three-engined bugaboo again! Was he the only one with faith in his single engine idea?

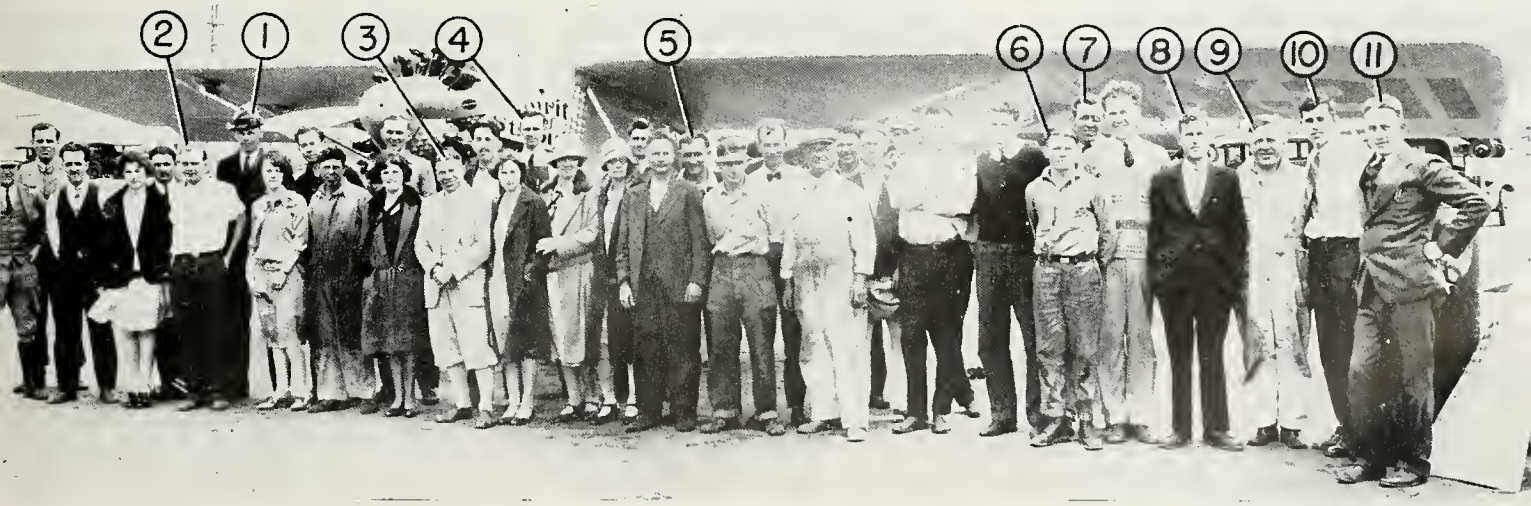
Perhaps he could make some headway if he spoke to Giuseppe Bellanca himself. Yes, says Bellanca at a meeting with Lindbergh in New York, his single-engined Wright-Bellanca could make the flight from New York to Paris, nonstop, with a big gas tank in the cabin. Lindbergh's hopes soar again as he returns to St. Louis. But they are dashed a few days later when the Wright company refuses to release the Bellanca for a transatlantic flight. Bellanca has offered to build a tri-motored plane for $29,000, but Lindbergh is still determined to use a single-engined plane. Maybe Bellanca could build it.

In the meantime, several other St. Louis businessmen have joined Maj. Lambert in promises of financial support. They are willing to gamble on his single-engined principle. Divested of that burden, Lindbergh now can settle down to the paramount struggle—that of getting an airplane to meet his specifications.

"Now," writes Lindbergh in '33 Hours to Paris', "I'll sound out every builder of aircraft in the United States. The Travel Air Company at Wichita is producing a

(Continued on Page 22)

When "Spirit of St. Louis" was finished, Ryan's entire working force lined up for this photo with Lindbergh (1). Still at Ryan are Walter O. Locke (2); Fred Magula (5); John van der Linde (7); and J. J. "Red" Harrigan (9). Others numbered are the late A. J. Edwards (3), then sales manager; Fred Rohr (4), now president of Rohr Aircraft Corp.; Doug Corrigan (6), who won fame for his "wrong" way flight; Donald Hall (8), then chief engineer; Hawley Bowlus (10), then factory manager; and B. F. Mahoney (11), then firm president.



"33 HOURS TO PARIS"

(Continued from Page 21)

plane that might do, and I've read of a monoplane with unusually good performance (the Ryan M-1 and M-2 mail planes—ed.), built by a company named Ryan, out in San Diego. The Travel Air Company is nearer. I'll telegraph them first. A reply comes back quickly. Travel Air won't accept the order. All right, there's the Ryan company, new and small and not well known, but I'll try them. And then I'll send wires to Curtiss and Boeing and Douglas and Martin. I'll sign the messages, 'Robertson Aircraft Corporation'—Major Bill gave me permission to do that."

In San Diego, on Feb. 3, 1927, T. Claude Ryan, founder of Ryan Airlines four years previously, was handed a telegram by his secretary, Georgia Mathias. Although Ryan had sold his interest in the company two months ago to his partner, B. F. Mahoney, he had stayed on temporarily as general manager.

The historic telegram, which was to set into motion a chain of events opening a new era in American life, read:

"CAN YOU CONSTRUCT WHIRLWIND ENGINE PLANE CAPABLE FLYING NONSTOP BETWEEN NEW YORK AND PARIS STOP IF SO PLEASE STATE COST AND DELIVERY DATE."

Mahoney was out of town at the time, so Ryan called in the company's first full-time engineer, young Donald Hall, who had been hired only a few days before.

After some rapid calculations, they sent this reply:

CAN BUILD PLANE SIMILAR M ONE BUT LARGER WINGS CAPABLE OF MAKING FLIGHT COST ABOUT SIX THOUSAND WITHOUT MOTOR AND INSTRUMENTS DELIVERY ABOUT THREE MONTHS.
RYAN AIRLINES

Well, the price was right. But, Lindbergh asks himself, "How reliable is the bid? Does the Ryan company have capable engineers? But here, at least, is interest and quick action."

To another telegram from Lindbergh asking for specifications and a quicker delivery date comes another prompt reply:

GAS CAPACITY 380 GALLONS CRUISING SPEED 100 MILES PER HOUR LOADING ONLY TWELVE AND HALF POUNDS PER FOOT AND TWENTY POUNDS PER HORSEPOWER STOP CAN COMPLETE IN TWO MONTHS FROM DATE OF ORDER IF NECESSARY STOP WILL REQUIRE FIFTY PERCENT DEPOSIT.

Lindbergh in "33 Hours to Paris": "I take the telegrams to Bixby and Knight (two of his St. Louis backers). They've never heard of Ryan. What kind of plane does the company make?

"It's a high-wing monoplane,' I tell them, 'like Bellanca's, only it's got an open cockpit and the span is shorter. Some of them carry mail on the West Coast'."

"We agree that I should go to California to see the Ryan people. I can start within a week. If we decide to buy, I'll stay in California while the plane is being built."

At this juncture, an unexpected telegram arrives from Bellanca, who suddenly is willing to offer the Wright-Bellanca for the transatlantic flight. Lindbergh is urged to come to New York as soon as possible.

In Lindbergh's mind, the Wright-Bellanca is still the ideal plane for the venture. Here is a plane ready to go. He'll be ahead of his competitors.

On arrival in New York, Lindbergh learns that the Columbia Aircraft Corp., —Charles Levine, board chairman, Clarence Chamberlin, pilot,—has purchased the Wright-Bellanca. Levine says the Bellanca is worth $25,000, but he's willing to sell for $15,000, contributing $10,000 for the advertising value.

Lindbergh returns to St. Louis, finds that his backers have the $15,000 ready. They also have a proposed name the Spirit of St. Louis.

Another trip to New York. Lindbergh places the check on Levine's desk, and then comes the shocker:

"We'll sell our plane," says Levine, "but of course we reserve the right to select the crew that flies it. Your organization in St. Louis would have all the credit for the flight, all the publicity."

Lindbergh had naturally assumed the plane would be sold outright; bitterly disappointed, he stalks out of Levine's office, carrying the $15,000 check.

This is the third week in February, 1927. "Fokker, Wright, Travel Air, Columbia—one company after another has turned me down. If I go out to San Diego, will the Ryan offer collapse too?"

And anyway, someone is certain to take off for Paris before Ryan could build the plane. Lindbergh's dream is all but shattered. Nevertheless, he learns, on returning to St. Louis, that his backers were not faint-hearted.

"We'll put the money back in the bank," Bixby says, "and it will be ready when you need it. You may decide that Ryan can do a pretty good job. Let's stay with this Paris flight. We're not whipped yet."

In balmy San Diego, on Feb. 23, 1927, a taxicab deposits Lindbergh at the Ryan Airlines factory, "an old dilapidated building near the waterfront."

In a paper-strewn office, Lindbergh meets Hall, the engineer; Mahoney, the president, who had returned from his out-of-town trip, and other Ryan people.

They got down to business immediately. After sketching a monoplane which he believes can achieve the herculean take-off, Hall is startled—as was everyone else—that Lindbergh plans to fly alone.

"I'd rather have extra gasoline than an extra man," Lindbergh sums it up simply.

The price is figured at $10,580 with

AIR PIONEERING OF RYAN TOLD

Ryan Airlines, Inc., which built the "Spirit of St. Louis," was founded by T. Claude Ryan in 1922. Its first activities were sightseeing flights, flight training and aerial photography.

In 1925, to obtain additional capital, Ryan took in as partner B. Franklin Mahoney, a local sportsman. Ryan Airlines then started scheduled air service between San Diego and Los Angeles, becoming the nation's pioneer year 'round passenger line. Four-passenger biplanes rebuilt for the purpose in the Ryan shops were used. The first Ryan-designed airplanes, the Ryan M-1 monoplanes, were manufactured that same year.

By the end of 1926, Ryan sold his financial interest to Mahoney who then owned control and became president of the small company. Ryan himself remained as an employee in a management capacity. It was during this period that Lindbergh's Ryan monoplane was built. Claude Ryan, head of Ryan Airlines until a few weeks prior to the trans-Atlantic flight, was not its owner or president when Lindbergh's flight electrified the world.

The original company was soon caught in the dizzy boom in aviation stocks that followed. Mahoney sold out and the factory operations were moved to St. Louis, where the company went out of business as the stock market collapsed.

In the meantime, Claude Ryan started over again in flying operations, aircraft engines and building the Ryan S-T series of sport and training planes. That new beginning, by 1931, was incorporated as the present Ryan Aeronautical Company which has continued its sound growth for the past 22 years.

the new Wright J-5 Whirlwind engine.

Lindbergh likes the enthusiasm he finds and is impressed with the ability of the company's technical people. "And the price," he writes in his book, "is inside the $15,000 raised by my partners in St. Louis. I send them a telegram, outlining Ryan's offer and recommending that we close the deal. Back comes a wire telling me to go ahead. We've already chosen a name for our plane; it will be The Spirit of St. Louis."

LINDBERGH watches the newspapers apprehensively as other prospective Atlantic conquerors seem poised for their take-offs.

"In the Ryan factory the workmen are out to set a record in construction time," Lindbergh recalls. "They're reading the papers too. We're in the second month. I've thought out my flight plan, even what to do if I have to land at sea. Sometimes I go out to Dutch Flats (Ryan Airlines field) and fly one of the company's standard machines to learn the characteristics of high-wing monoplanes. . . .

"An atmosphere of tension pervades the Ryan factory. Workmen sign their names on the front wing spar before the fabric cover is added. My equipment for emergency at sea is all purchased—rubber raft, water canteens, canned Army rations, railroad-type flares. I've got each flare sealed in a watertight piece of bicycle inner tube. Whenever The Spirit of St. Louis is ready, I'll begin flight tests. For the heavy-load tests, Hall suggests using the long parade ground on an abandoned Army post at Camp Kearney."

It is late April. The factory job is done. The loft's double doors have to be removed to get the 46-foot wing out. The fuselage goes through the factory door easily. Both are towed to Dutch Flats and assembled there.

From the east come crackling reports of doom to all the multi-engine planes being prepared for the transatlantic flight —Rene Fonck's Sikorsky, Commander Richard Byrd's Fokker, Lieut. Comdr. Noel Davis's Keystone. Four men have been killed, three injured. Even the Wright-Bellanca has had a crackup. Fate is narrowing the focus on Lindbergh.

On April 28, 1927, exactly 60 days since work on The Spirit of St. Louis began, Lindbergh takes it up for the first time from Dutch Flats, spirals to 2,000 feet over San Diego Bay. He notes that stability isn't its strong point. But that was intentional. "We didn't design for stability; we accepted small tail surfaces and designed for range."

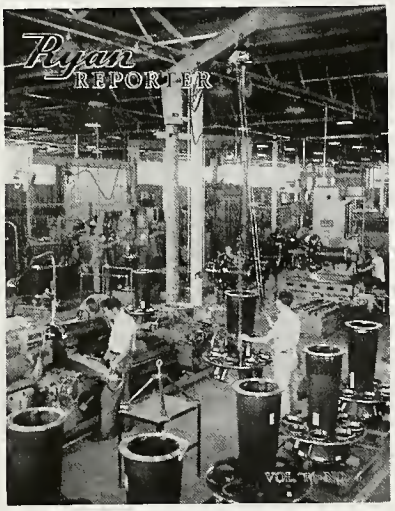
The base of operations shifts to the old Camp Kearney abandoned parade ground on May 4. Hall is busy charting theoretical performance curves. Fifty gallons of gasoline are added for each succeeding takeoff.

"In the 300-gallon test, my plane is off the ground in twenty seconds, but the tires take a terrific beating, and landing with the gas load is even rougher," Lindbergh reports.

John van der Linde (now production manager of Ryan Aeronautical Company, then chief mechanic for Ryan Airlines) is in charge of the fueling. He asks Lindbergh if he wants to try it with another 50 gallons. Lindbergh had intended to take loads up to 400 gallons, but he's worried. Suppose a tire blows? The whole project would end at Camp Kearney!

Besides, he's eager to start his adventure. On May 10, 1927, with all his bills paid, and confident in his fragile-appearing plane, Lindbergh stops at the Ryan factory to say goodbye to the men whose intense zeal and devotion to their jobs had created this flying machine in the seemingly impossible period of 60 days. He drives to Dutch Flats, flies across the bay to Rockwell Field on North Island, is fueled and takes off for St. Louis, where he lands 14 hours, 25 minutes later. It was the fastest flight ever made from the west coast.

The Spirit of St. Louis was on its way —vaulting from obscurity to immortality in the most dedicated days of aviation history.



ON THE COVER

A lot of "skeletons" are moving through Ryan's jet building. They are aft frames which form the "backbone" of General Electric jet engines. Almost two million dollars worth of massive machines are used to build these complex structures and machine their mirror surfaces with jewel-like precision.

TIME TELESCOPED

(Continued from Page 9)

by mid-air refueling from KC-97s, the B-47 complements the long-range heavy bombers now available, such as the B-36. The combination gives the SAC the ability to strike swiftly and repeatedly from many bases at major targets, Gen. Mooney pointed out.

The B-47s have been rapidly building up a reputation of being able to "go anywhere, do anything." Their crews are the acme of versatility. It takes only three men to operate a B-47, but each must be able to serve as pilot, navigator or bombardier.

In Capt. Carter's record-breaking plane, for instance, the other two crew members, both senior to him, shared the piloting and navigating chores. They were Lieut. Col. Ben Klose, a squadron commander, and his deputy, Lieut. Col. Lawrence Grant. Each also performed simulated bombing in mock attacks at selected points during the crossing.

The B-47s are accustomed to shattering records. When the Aviation Writers' Association met in Fort Worth, Tex., at its annual convention last May, a well-kept secret was disclosed—that last year, all existing distance and endurance records for jet aircraft had been broken by a Stratojet, operated by a test crew from Edwards Air Force Base, Calif.

This plane flew more than 12,000 miles over the southern and western parts of the United States in 24 hours through the use of aerial refueling three times from KC-97 Stratotankers. A dummy 10,000-pound bomb was dropped halfway in flight to simulate a long-range strategic mission.

At the same time, the Air Force revealed that a B-47 had made the first jet flight over the North Pole, also last year, from Eielson Air Force Base near Fairbanks and then back to Alaska after circling the top of the world.

The conquest of time and space has become routine for two great American planes, the Douglas DC-6B airliner and the Boeing B-47 Stratojet bomber.

SPECIALIZED and VERSATILE

(Continued from Page 1)

hand knowledge of problems encountered in both high speed flight and high temperature metallurgy.

Thus, Ryan experience, gained in each specialized field, is integrated and placed at the immediate disposal of design engineers, test pilots, metallurgists, electronics engineers, aerodynamicists and production engineers throughout the plant.

ORGANIC FLYING IN THE ARMY

(Continued from Page 17)

wire laying, limited aerial photography, battlefield illumination, transportation and other vital missions.

His aircraft are as unquestionably accessible to him as are his jeeps or his trucks.

The higher headquarters also have aircraft organic to them and to their headquarters units. For example, a Corps Headquarters has organic to its headquarters units approximately twenty-one aircraft. An Army headquarters has approximately sixteen aircraft.

The principle of decentralization applies also to the officers who fly Army Aircraft. Army aviators are not solely pilots, but rather, they are officers recruited from among those branches employing organic aircraft. They know the problem of the man on the ground because they are themselves ground trained officers. They are returned to ground duty periodically to remain qualified in their basic branch of service.

The mission of Army aviation may be very simply stated: It provides the combat commander with immediate access to the air for the purpose of observation and transportation. It has been and will continue to be the tool of the ground commander, operated by his personnel and used as he sees fit. Army aviation does not duplicate any function of the Air Force. It does not carry any weapons, and it is not used for large scale air movements over great distances. Army aviation is a further and logical step in the evolution of basic Army mobility. The Army is adopting aircraft as it adopted the motor vehicle not so many years ago.

At the beginning of the hostilities in Korea, the Army had approximately twelve hundred pilots and was operating three types of aircraft; the two place fixed wing observation plane, the multiplace fixed wing plane (Ryan Navion L-17 Ed.), and the utility helicopter. During the three years since the Korean affair began, the number of Army aviators has increased to approximately three thousand, of which about one third are qualified to operate helicopters as well as fixed wing aircraft.

Army helicopters have evacuated over 10,000 casualties from forward areas within the combat zone since hostilities began. This has been accomplished solely by small helicopters using outside litters, and carrying only two casualties per trip. Medical evacuation of casualties from the battlefield has been revolutionized by the application of the helicopter. It is now possible to save many lives that would have been lost otherwise, since casualties can be moved rapidly from the point where they occur to a facility fully equipped to treat them.

THE helicopter is finding other uses on the battlefield also. The aircraft used to evacuate casualties carries urgently needed medical supplies when returning to front line units, as plasma, whole blood, drugs, instruments and even blankets. Both fixed and rotary winged aircraft are being used by the Signal Corps to install and maintain communications. Telephone wire can be laid to any point over all kinds of obstacles in a minimum of time. Radio relay stations can be sited in a matter of minutes where formerly it took hours or days. Important maps, orders and other documents which must be hand carried, now reach their destination more rapidly than ever before, regardless of limited road nets and heavy traffic.

Engineers are using aircraft to locate suitable bridging sites, determine the condition of existing bridges and roads, and find scarce building materials in a minimum of time. They use them in surveying and mapping operations, both for transportation to inaccessible areas, and as survey stations.

Army aircraft in Korea provide the bulk of all observation for artillery fires. Eight out of every ten artillery missions fired in Korea are adjusted by an observer in an Army airplane.

Commanders at all levels now choose aircraft over ground transportation for their ground visits and inspections. They are enabled to visit a greater number of their subordinate units and to maintain a much closer relationship with their front line elements than ever before. The broader personal familiarity with the situation across the entire front makes it easier for any commander to reach prompt and correct tactical decisions. On his recent visit to Korea, General Eisenhower was transported to the various command posts and installations by an Army aircraft flown by an artilleryman.

With the brief description that I have given of the organization and general mission of Army aviation as a background let us now consider the types of aircraft required by the Army and the means by which we are attempting to obtain these types. Our aviation research and development is aimed at the goal of providing for Army use, nine types of aircraft with associated equipment.

These nine types can be grouped into three general categories; the fixed wing,

(Continued on next page)

A.I.A. COMMITTEE VISITS RYAN

For the first time in its history, the Statistical and Reports Committee, western region, Aircraft Industries Association, visited San Diego recently, and toured the Ryan plant at invitation of Dale Ockerman, company assistant secretary and assistant treasurer, a member of the committee.

The Ryan inspection was made at conclusion of the monthly business meeting in the Institute of Aeronautical Sciences headquarters in San Diego. William Brotherton, of Ryan public relations, conducted the visitors through the plant.

Purposes of the Committee's work are the coordination and simplification of the various reports required from the aircraft companies by government agencies. In this realm, the Committee has eliminated duplication between the companies, streamlined reporting procedures and saved government departments valuable time by quickly providing correlated information.

Members who attended the San Diego meeting and Ryan plant tour are: I. A. Crawford, Chairman, Lockheed; J. D. Ramsey, Douglas; W. E. Capp, Chance Vought; William Hummel, North American; S. Y. Johnson, Convair; W. A. Raborg, Northrop; E. B. Tupper, North American; and J. R. Bachman, Aircraft Industries Association.

the rotary wing and the convertiplane. In the fixed wing category we employ a two place plane for observation. A multi-place plane is used for general utility, such as carrying light cargo loads and small numbers of individuals. The third member of the fixed wing family is the command type, used for executive transport.

In this field we are looking for improved models with better performance, greater dependability, and lower operating costs. We expect to find this as we have in the past, essentially on the selves of aircraft manufacturers. We have been able to effect great savings without loss of effectiveness by availing ourselves of the best in light aircraft that the industry had to offer. We expect to continue that policy.

In the rotary wing category, the cost of development of each item is considerably greater than that of comparable fixed wing aircraft. With several exceptions it has been necessary for the services to obtain suitable helicopters through design competitions and to shoulder the financial burden of development. The major expenditures of Army R&D funds for aircraft is being made on rotary-winged aircraft. In the rotary wing category the Army has requirements for five types; the 2-place reconnaissance-trainer, the multiplace utility primarily for medical evacuation, the 3,000 lb. and 6,000 lb. payload cargo helicopters and the heavy lift or flying crane type helicopters.

IN many instances the Navy and the Air Force had previously initiated development projects on cargo type helicopters suitable to Army use. To avoid duplication of effort, to save time and the taxpayers money the Army is actively participating in a number of these development programs.

A small collapsible, airdroppable pulse-jet helicopter has been developed by the American Helicopter Company as a purely Army project. It is the first such aircraft developed for military use. The purpose of this development is two-fold: first to investigate the use of jet power in a helicopter and its effect on simplification, lower production costs, and reduction of maintenance; and second, to develop an aircraft capable of use in the aerial reconnaissance and observation role in Phase I of an airborne operation.

The final or 9th type of aircraft under development for the Army is the convertiplane. This aircraft combines the vertical rising features of the helicopter with the higher speed longer range features of the fixed wing aircraft. The Army initiated action for development of a convertiplane in 1950-51. This marked the first active interest by any service on this type of aircraft. Contracts were let to McDonnell, Sikorsky, and Bell on three different approaches to the problem of convertibility.

Known as the "Jet Jeep," this American Helicopter Company's XH-26 model is a new pulse-jet and the first of its kind developed for military use by the Army. It was built to investigate the use of jet power in a helicopter and its effect on simplification, lower production costs, and reduction of maintenance.

In the Army we are looking for helicopters with high weight lifting capacity and modest range. We are seeking ruggedness that will stand the day to day usage of the combat zone, dependability sufficient to form a keystone in battlefield logistics, and simplification of maintenance to reduce costs of operation to compare favorably with other means of transportation. We recognize the relative newness of the helicopter field but are much encouraged by the great strides already made by industry in meeting our needs.

To summarize, Army aviation has grown from a few airplanes used only for field artillery observation, to an Army wide facility used by all of the combat arms and many of the services. Our equipment has changed from a few small civilian-type "cub" airplanes, to a variety of types including twin-engined fixed wing aircraft and to the largest rotary wing aircraft procured.

The unchanging feature in the Army aviation picture is the fact that regardless of growth and development, Army aircraft still remain in the possession of the ground commander, thoroughly woven into the pattern of operation of ground troops. The Army's manner of employing aircraft insures that, regardless of the numbers of aircraft involved, Army aviation does not and will not duplicate any function of any other service.

IN closing let me assure you that we in the Army are well aware of the large part played by industry in establishing Army aviation. Industry has produced the constantly improved aircraft that have enabled us to derive the greatest value from our aviation. Industry is striving now, to gain more rapidly the knowledge that will enable it to meet our urgent requirements. We are grateful for this, and are confident of the ability of industry to meet the call of the future.

However, among the greatest immediate problems facing us are those of high initial cost, high cost of maintenance, and complexity of design. To satisfy the Army's needs, aircraft must be simpler, easier to maintain, cheaper and more reliable. We require the help, and depend upon the efforts of the aircraft industry to meet these needs.

FIVE DECADES OF FLIGHT

(Continued from Page 15)

day are today's commonplace occurrences. Vaulting through the sound barrier once carried a superhuman connotation. It's an accepted fact today.

This feast-or-famine, boom-or-bust industry—in which there are now encouraging signs of emergence of an orderly procurement and development program—was largely built on the trial-and-error experimentation of thousands of individuals like the Wright brothers.

First the Wrights built gliders. Their performance proved discouraging, and the brothers were almost ready to abandon the whole idea and concentrate on their prospering bicycle business in Dayton. However, in the winter of 1901-02, they set a more scientific course for themselves. They built what might well be described as a wind tunnel—perhaps the world's first. It was simply a box eight feet long and 16 inches square. Through it they blew air with a propeller spun by a crude two-cylinder gasoline engine. They compiled a table of air pressures as they studied lift and drag on more than 200 wing sections.

With this information to help them, they designed a new glider, and between August and October, 1902, on Kill Devil Hill, Kittyhawk, N.C., their flights were the most promising yet. They made 1,000 takeoffs and learned how to control the craft in winds up to 36 miles an hour.

Hence, when they returned to Kittyhawk in December, 1903, with an airplane equipped with an engine, they had an unparalleled fund of knowledge, based on the glider experiments, about stability, control and balance.

Their engine, which they had designed for 8 horsepower, surprisingly generated 12 h.p., allowing them 150 pounds more for reinforcing the plane. But the propeller baffled them. Just how much was explained by the brothers later:

"With the machine moving forward, the air flying backward, the propellers turning sidewise, and nothing standing still, it seemed impossible to find a starting point from which to trace the various simultaneous reactions."

AFTER several months of calculations, they managed to create a propeller that provided amazing efficiency.

Nine days before the Wrights made their first sustained flight on Dec. 17, 1903, Dr. Samuel P. Langley, the noted secretary of the Smithsonian Institution, had failed to take off in a plane which the government had financed by a $50,000 grant. Thus, although the Wrights had invited persons in the area to witness their attempt, only five showed up.

"Not many were willing to face the rigors of a cold December in order to see, as they no doubt thought, another flying machine not fly," the Wrights recalled, referring to the Langley failure.

There was little attention paid in the press to this historic first sustained flight. The Wrights themselves did not crow about their achievement. They went back to Dayton, intent on improving their flying machine. They built a shed on the prairie eight miles east of Dayton in the spring of 1904 and began an intensive series of flight tests. This field might well be considered the world's first "airport."

By 1905, they were able to make a six-mile flight, and the residents of Dayton and vicinity were taking for granted the strange aerial gyrations of the Wright brothers. Nevertheless, in 1906, their work was so little known abroad that when the pioneer French flier Santos-Dumont flew more than 80 feet, he won a 3,000-franc award, and he considered himself the first man to operate a heavier-than-air powered plane.

Competition to the Wrights came in 1907 in the person of Glenn Curtiss, a motorcycle manufacturer, who with Alexander Graham Bell and others formed an airplane production company, the Aerial Experiment Association, at Hammondsport, N.Y. Within a year, the firm had built four planes, after which Curtiss, now with an established reputation as a designer and builder, as well as a flier, went out on his own.

Curtiss became the most renowned aviator of his day. He won numerous races here and in Europe, and in 1909 he performed the remarkable feat of flying from Albany to Governor's Island, New York, 142 miles, with only three stops and an average speed of 49 miles an hour. He went into quantity production of his planes, and in 1910 he developed his first successful hydroplane.

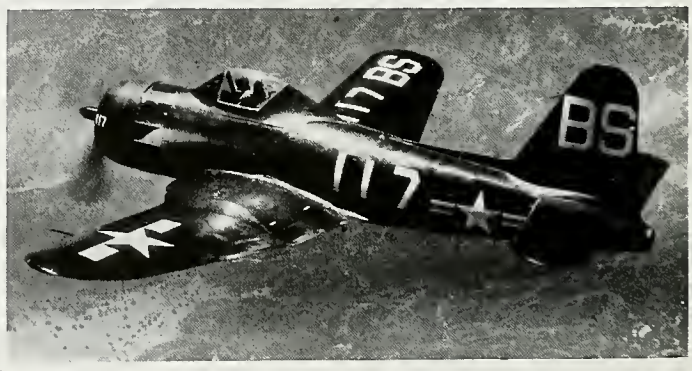
By 1909, only six years after the Wrights left the ground, one of aviation's immortals, Louis Bleriot, the Lindbergh of his day, staggered the imagination of the world much as did Lindbergh with his transatlantic flight in 1927. Bleriot flew the English Channel in a tiny, sturdy monoplane of his own design after having survived 50 crashes in experiments with a series of gliders and airplanes. It took him 37 minutes to fly the 31 miles from Les Baraques to Dover, earning for him the London Daily Mail's prize of 1,000 pounds.

Disciples of the Wrights and of Curtiss were attending their flying schools by 1910, and as more and more persons were willing to risk their necks, the airplane itself improved rapidly. Fuselages were enclosed, pusher power was replaced by tractor power, steel tubing was employed, radio transmission was successfully demonstrated, and the planes gained speed as cleaner lines were developed. When World War I broke out, the average modern airplane had 200 h.p. engines, were able to cruise 600 miles non-stop and could climb to about 13,000 feet.

The airplane was a machine of peaceful purpose until World War I, when

(Continued on Page 28)

1943 **During World War II, special distinction was won by Martin Mars, left, first designed as long range bomber but later converted to transport that set records for passengers carried. Also during World War II, Ryan "Fireball," right, was the first jet fighter to operate from an aircraft carrier and also was the first combination jet and piston engine plane.**



BIRTHPLACE OF THE ATOMIC AGE

(Continued from Page 5)

130 feet long. The equipment, suspended about 100 feet below the balloon, weighs from 10 to 50 pounds.

The amazing capabilities of remote control are illustrated by the method in which a sample of upper air is brought back to earth at Holloman. A thermos bottle was sent up in a rocket to an altitude of 75 miles, where the cork came off, the bottle was filled with air, and was then automatically closed. This was made possible by a complex instrument of the type that may take several years to develop at such places as the Cambridge, Mass. Research center, which with Holloman ADC is one of nine units of the Air Research and Development Command, headquartered in Baltimore.

Before a typical rocket can be launched, six men dressed in asbestos suits work five hours preparing it for its sizzling flight into space. Although the actual launching may be a pushbutton affair, the entire operation is governed by four men manipulating sensitive controls in a block house.

Under the jurisdiction of the 6580th Missile Test Group at Holloman, guided and ballistic missiles, guided bombs and target aircraft are tested in actual flight, while components are tested under simulated missile flight conditions. The Air Force has revealed that among new weapons undergoing tests are a surface-to-air supersonic missile, remotely controlled, for intercepting hostile aircraft; a high-angle controllable bomb; and a subsonic surface-to-surface guided missile of medium range.

An instrument with the tongue-twisting designation, Askania Cinetheodolite, is used to photographically record missile flight and scoring cameras to observe the proximity of target hits.

Scientists at Holloman are learning about radio wave propagation at high frequencies; the electrical characteristics of the ionosphere; the composition and acoustical properties of the upper atmosphere; the intensity of radiation from the sun, nocturnal space, and from the earth; high altitude winds, and the biological effects of cosmic radiation and reduced gravity.

All this has bearing on the future designs of missiles and aircraft which must pass through the lofty reaches of space to reach their destination.

Holloman is the scene of daily flights of "ghost" planes—drones that are guided through the sky by "mother" planes or by "beeper" pilots at control panels on the ground. Pilotless QF-80's and QB-17's fly as targets for guided missiles, and on other missions. Drones with terrific speed, like the Ryan jet "Firebee," flash across the desert on test runs. Smaller target planes are launched with Jato assist and zigzag by remote control.

Here aviation's "pushbutton" era is being previewed as scientists, technicians and military men seek to penetrate the curtain that has screened off the mysteries of great altitudes and great speeds.

RYAN ADOPTS NEW TYPE CARD PAYCHECK SYSTEM

History was made at Ryan when paychecks of the exact size and shape of postal money orders, even to the stubs, were distributed for the first time recently.

Ryan is believed to be the first industrial plant in the United States to inaugurate the use of this particular type of card for checks, replacing soft paper checks, according to Lester E. Hill, chief of tabulating.

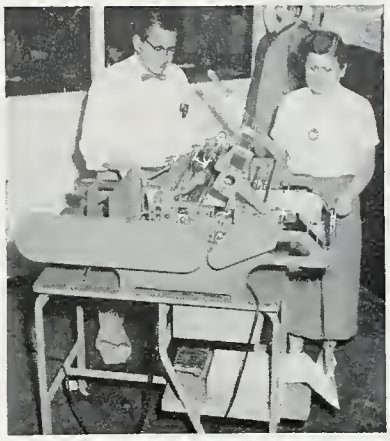
Its further significance is an anticipated substantial annual saving in office expenses, due to the speed of the new equipment used in turning out the checks, and the ease of handling cards rather than soft paper.

In the past, the paper checks had to be hand-sorted; this is now a machine operation. Considerable time also is saved in bank reconciliation. Hitherto, paper cancelled checks had to be converted into tabulating cards; now the cancelled card check itself can be used for reconciliation.

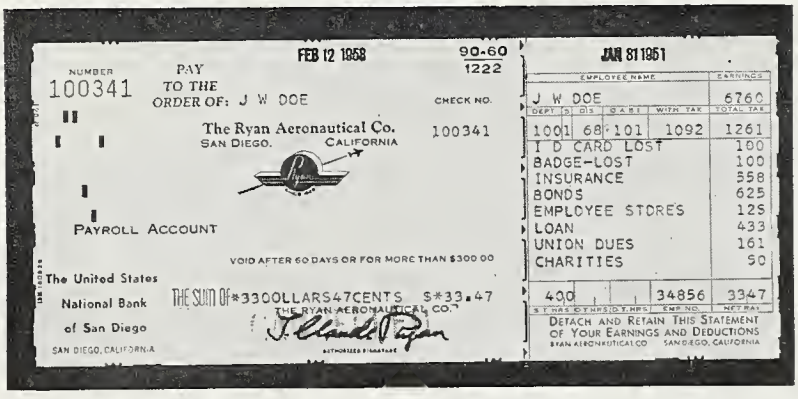
For employees, the checks are more easy to read. Tax and other payroll deductions are listed vertically, instead of horizontally as in the past.

The card forms can be adapted to other purposes, such as inventory tags, billing notices for public utilities, etc. The same type card, without the stub, has been used at Ryan for some time as time cards and requisition cards.

Payroll information for the checks is now obtained from a new electronic computer, and is then transmitted to a tabulator for printing on the card checks. Finally, long strips of card checks are sent through a new machine, a detacher-imprinter on which International Business Machines of Endicott, N.Y., and Moore Business Forms of Niagara Falls, N.Y., have collaborated. This machine detaches each check while printing the date and President T. Claude Ryan's signature.



NEW TYPE MACHINE — Detacher-imprinter separates checks fed into it in long strips, while printing date and President T. Claude Ryan's signature. Left to right, D. E. Pickard, general supervisor, tabulating; and Ida R. Clements, assistant supervisor.



NUMBER 100341 — PAY TO THE ORDER OF: J W DOE — FEB 12 1958 — 90-60 / 1222 — CHECK NO. 100341

The Ryan Aeronautical Co. SAN DIEGO, CALIFORNIA

PAYROLL ACCOUNT

VOID AFTER 60 DAYS OR FOR MORE THAN $300 00

The United States National Bank of San Diego — SAN DIEGO, CALIFORNIA

THE SUM OF *3300LLARS47CENTS $*33.47 — THE RYAN AERONAUTICAL CO.

JAN 31 1951

EMPLOYEE NAME	EARNINGS
J W DOE	6760
DEPT. 1001 / S 68 / DIS 101 / GARN / WITH TAX 1092	TOTAL TAX 1261
I D CARD LOST	100
BADGE-LOST	100
INSURANCE	358
BONDS	625
EMPLOYEE STORES	125
LOAN	433
UNION DUES	161
CHARITIES	90
400 / 34856	3347

DETACH AND RETAIN THIS STATEMENT OF YOUR EARNINGS AND DEDUCTIONS — RYAN AERONAUTICAL CO SAN DIEGO, CALIFORNIA

FIVE DECADES OF FLIGHT

(Continued from Page 26)

the concept of aviation's role in power politics was born. With this concept came the establishment of an organized aircraft industry. Engineers were now able to utilize scientific data accumulated over the years of stumbling investigation by the pioneers. The industry made great strides during World War I, when it produced almost 14,000 planes and 42,000 engines, although comparatively few were completed in time to be used in actual combat. However, in the race to get the best combat planes to the front, phenomenal advancements were made in aircraft design.

That war was followed by the first of aviation's series of famines following feasts. Contracts were terminated immediately after the Armistice, thousands of war-surplus planes were dumped on the market, and aircraft manufacturing went into a drastic slump through most of the twenties.

Lindbergh's flight from New York to Paris in the Ryan monoplane, "Spirit of St. Louis," awakened aviation from its doldrums, private flying soared in popularity, the demand for planes skyrocketed, many new companies were formed, and by 1929, 100,000 persons were employed in the aircraft industry.

IN the lean years before the Lindbergh flight, barnstorming pilots, willing to chance their lives against the prospect of a small fee at circuses or county fairs, did more than any other group in bringing the thrill and exhilaration of flying to millions of persons all over the country.

And there were the "big league" barnstormers, the long-distance fliers, military and civilian, who focused attention on aviation. In this category were Army Air Corps Lts. John A. Macready and Oakley Kelly, who made the first nonstop flight across the United States in May, 1923, from New York City to Rockwell Field, San Diego, in 26 hours, 50 minutes, in a 375-h.p. Fokker single engined monoplane; and the Navy fliers who in May, 1919, attempted to cross the Atlantic in four heavy Curtiss NC flying boats, one of which succeeded in reaching the Azores from Newfoundland. It was the first plane to succeed in conquering the Atlantic. The following month, two former British Royal Flying Corps officers, Capt. John Alcock and Lt. Arthur Brown, became the first to fly the Atlantic nonstop, from Newfoundland to Clifden, Ireland.

This also was the decade when the Navy learned to adapt aviation to its own medium, the sea. It created a floating landing field by converting the collier Jupiter into the first aircraft carrier Langley. This proved so successful an experiment that two cruisers also were converted into carriers, the famous original Saratoga and Lexington.

Other fliers were more methodically making history — by carrying the mail and, occasionally, passengers over inadequately marked airways and in the most miserable weather. The foundations were being laid for the greatest airline network in the world. Meanwhile, General Billy Mitchell was drumming away on the American mind with his thesis that airpower was now to be considered the first line of defense. For his heretical beliefs, he was court-martialed and stripped of his rank, a martyr to principles which long ago have been more than vindicated.

The Depression plunged aviation into an abyss that reminded aviators of the early and middle 20's, when fliers were wont to say that their greatest hazard was starvation. In 1929, production was 6,034 planes. By 1933, the annual output was only 1,057. Military aircraft production was almost at a standstill, plunging the United States to sixth place among world powers in combat air strength in the mid-Depression year of 1936, when the Army Air Corps had only 300 planes fit for combat.

During these troublous times, the first of the modern air transports were making their appearance,—the Boeing 247, the Lockheed Electra, the Douglas DC-2. In a strongly competitive climate and under conditions of economic stress, the airlines managed, through efficient operations and consolidations that weeded out the marginal performers, to grow and eventually to prosper.

While Hitler was building the world's most potent air force, the United States literally marked time until 1939, when England and France, faced with doom, frantically placed large production orders for combat planes which were ready for the assembly lines. Thus, by the time of Pearl Harbor, the American aircraft industry had a running start in its productive capacity which was eventually to crush the enemy. President Roosevelt's call for 50,000 planes in 1940 set into motion the complex processes by which a mighty Air Force is built and the entire face of American industry was changed, with aviation as its most prominent feature.

IT was a time for training hundreds of thousands of workers in new skills, a time of mass employment of women in the aircraft industry as the draft drained manpower. Many other basic industries were converted to turn out planes or parts, but the nucleus, the tried performers, remained the aircraft plants which had weathered the starvation periods after World War I and during the Depression and had experienced the violent expansion of production in World War I.

In the feverishly-paced five years, from August, 1940 to VJ-Day in August, 1945, almost 300,000 military planes were built. At peak production, more than 2,000,000 workers were employed by the industry, its sub-contractors and suppliers. This was the greatest single manufacturing effort in history.

With the war's end, the boom-or-bust cycle again asserted itself. Thirty thousand planes were still in process and a backlog of more than 8 billion dollars existed when the blow came. Sweeping terminations plunged the industry to new depths. In 1946, the first postwar year, only 1,669 military planes were produced, compared with the 1944 peak of 96,318. The nation was virtually stripped of the power to defend itself in the atomic air age, and there was little to be optimistic about in aircraft plants which were more like echo chambers than factories.

The President's Air Policy Commission, appointed in 1947 to appraise the situation, warned that survival hinged on revival of the aircraft industry. The Commission's famous Finletter Report, named for its chairman, and the Congressional Air Policy commission both recommended a five-year gradual buildup, which would in its opinion provide not only the minimum defense needs but would save considerable money through orderly procurement.

(Continued on next page)

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FIVE DECADES OF FLIGHT

(Continued from Page 28)

But before production could roll with funds appropriated by Congress in 1948, President Truman impounded much of this money, and numerous contracts were cancelled.

The gloomy economic outlook did not deter research and development, however. Jet planes and guided missiles, designed but not put into mass production during World War II, were being perfected. The private plane market was beginning to show healthy signs, particularly in the business executive and industrial field, where the strictly utilitarian function of the planes was stressed.

Meanwhile, the great debate over airpower continued to rage inconclusively. The argument wasn't won by advocates of a buildup until the North Koreans swept across the 38th Parallel in June, 1950.

FOR the third time in its hectic half-century, aviation production was expected to boil into high gear virtually overnight. The hysteria wasn't as great as during World Wars I and II, but it was a new boom, one which ran parallel to the boom in consumer goods. Instead of claiming top priorities this time, the aircraft industry had to compete with other industries for skilled labor, materials and tools.

Failure to follow the Finletter Report's recommendations of gradual expansion meant an abnormal acceleration at tremendous cost. Meanwhile, the Soviet Union had been proceeding at a high rate of production. After three years of intensive effort, output of increasingly complex jet planes and guided missiles still has not achieved the air superiority strategists believe necessary to insure security.

Hampered by the almost disastrous stop-and-start philosophy of the past, the aircraft industry today has managed to achieve a production rate of 12,000 military planes a year, still 2,000 less than in 1918.

But there are signs of realization among the policy-makers that an adequate supply of planes cannot be created overnight to meet an emergency, that the industry must be maintained on an even keel through periods of relative international calm. Eventually, perhaps, the airplane may be devoted exclusively to peaceful purposes. Meanwhile, the United States, cradle of aviation, is committed to use this mighty force to protect free men from succumbing to tyranny.

ALLISON TOP ENGINEERS SURVEY RYAN PRODUCTION FACILITIES

Two top engineers from the Allison Division of General Motors Corporation visited Ryan recently to confer with Sam C. Breder, Director of Customer Service, and to survey Ryan's jet engine production facilities. Arriving from Indianapolis were John Eriksen and Edward Berlin (second and third from left as shown above).

After the conference, Berlin and Eriksen were conducted through the Ryan plant by C. L. Foushee, Jr., Ryan Service Manager, and Ralph Haver, Ryan design engineer. Ryan is designing and building a number of jet engine components for Allison, employing various types of stainless steel and low alloy steels in their fabrication.

Allison is currently producing the J-35-A-29 power plant which is used to power the Republic F-84G fighter-bomber. This jet engine is an axial flow type, incorporating eight combustion chambers, inner and outer exhaust cones and tail-pipes of stainless steel. It develops a static thrust of 5600 pounds for take-off at sea level.

RESEARCH AND DEVELOPMENT

(Continued from Page 13)

were incorporated in the Fireball's production. It was the Navy's first production plane to be flush-riveted on its entire exterior. This insured a smooth surface which minimized parasitic drag. The FR-1 was the first plane to take full advantage of the benefits of post-aged aluminum. By heating Alclad 24-S to 365° F. for ten hours, it was possible to enhance its tensile strength by a full twenty percent. However, this reduced the material's resistance to corrosion. Ryan laboratory chemists devised an anodizing and priming procedure which restored the lost corrosion protection. As a result, substantial weight was saved in the Fireball's design by utilizing thinner-gauge, high-strength Alclad.

A later version of the Fireball series, the XF2R-1, substituted a General Electrict TG-100 turbo-prop engine for the forward piston-type power plant. This was the Navy's first turbo-prop airplane and the first turbo-prop powered aircraft to make a cross-country flight. In this airplane, Al Conover, Ryan chief test pilot, performed the first experiments in flattening the propeller blades, in flight, to reduce air speed and steepen gliding angle of a plane having a single propeller. Conover also employed the propeller in reverse pitch to decelerate the Fireball's landing roll on the runway.

With another version of the Fireball, the XFR-4, Ryan pioneered, under NACA auspices, flush-entry ducts for feeding air to the buried jet engine in the fuselage. Faired into the sides of the fuselage, they eliminated wing ducts and air scoops.

Many Ryan research projects of yesterday have become commonplace sights of today. Tricycle-geared, jet planes are flying from carriers, turbo-prop power plants are being perfected and guided missiles are coming into their own. Now, Ryan is working on new problems to get the answers for developing the aircraft of tomorrow.

ANNOUNCING

THE NEW

RYAN FIREBEE

HIGH-PERFORMANCE JET TARGET

Latest product of creative Ryan aircraft engineering and manufacturing is the FIREBEE, the newest high-speed, high-altitude jet-powered aerial target plane. The FIREBEE is remote controlled and recoverable by parachute.

This new advance-type swept-wing jet aircraft has been developed as a jointly sponsored project of the Air Force, Army and Navy. It provides all the Armed Forces with an efficient answer to the vital need for a jet target with the performance characteristics of modern fighter aircraft.

The FIREBEE is another example in the long list of Ryan contributions to the advancement of aeronautical science.

RYAN

AERONAUTICAL COMPANY

AIRCRAFT AND AERONAUTICAL PRODUCTS

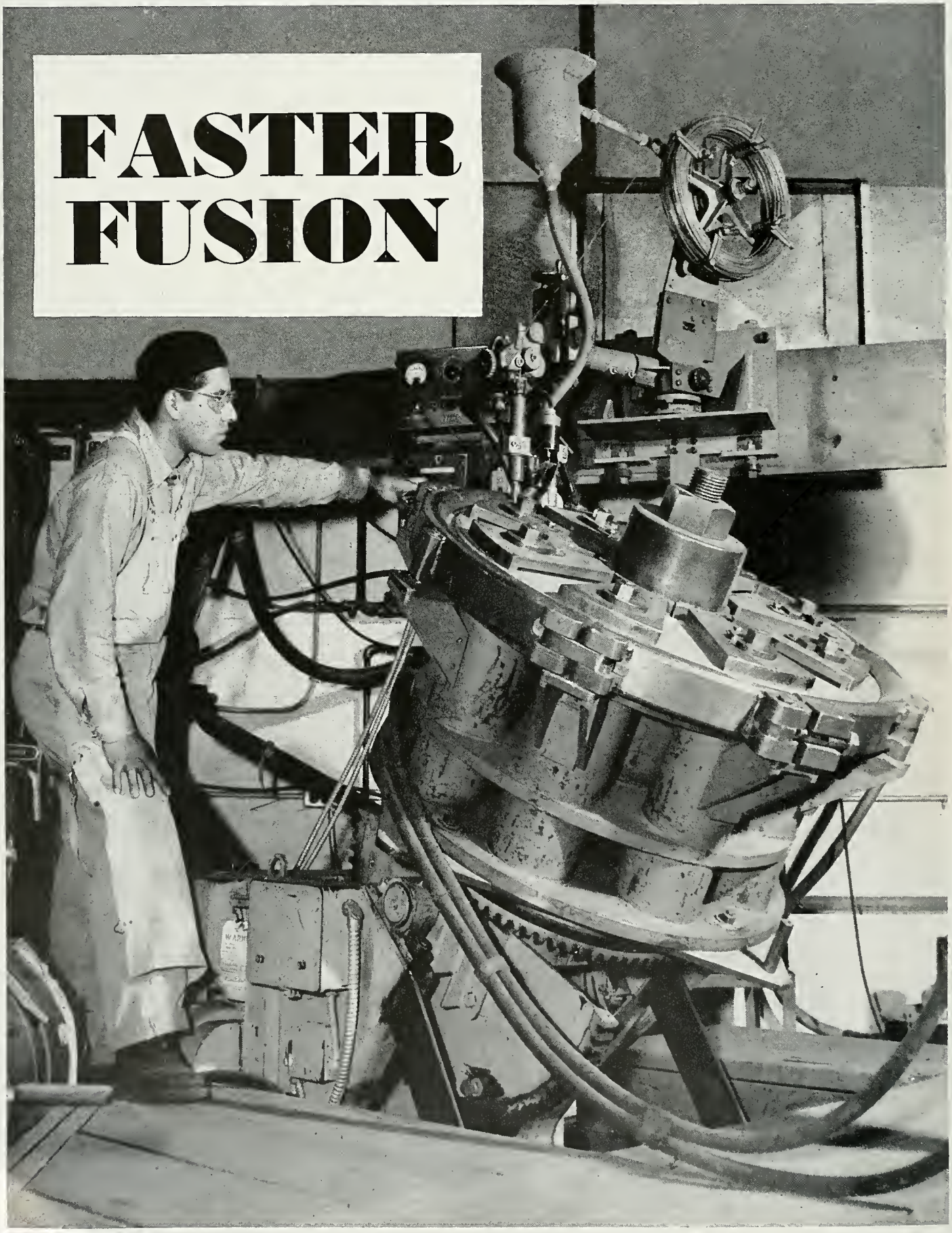
Ryan REPORTER

RYAN AERONAUTICAL COMPANY
SAN DIEGO, CALIFORNIA
Special Edition
for
SAE MEETING
Sept. 29 - Oct. 3, 1953 Los Angeles

SAN DIEGO home of many aviation firsts PROGRESS CELEBRATES 50TH ANNIVERSARY OF POWERED FLIGHT SECURITY

VOL. 14, NO. 5

FASTER FUSION



In a rotating Ryan fixture, Salvador Vargas welds a heavy jet burner plate with Unianmelt. Arc is avalanched in pawdered flux.

WOULD
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Sometimes the shortest distance between two points is an arc

A REVOLUTION in fusion welding has taken place at Ryan. During World War II, Ryan "stitched" thousands of aircraft and engine components together with acetylene gas, atomic hydrogen and metallic arc welding. Today, only metallic arc remains as a member of this fusion welding team.

The big switch has been to a newer method—inert gas-shielded arc welding, and Ryan has converted all acetylene gas and atomic hydrogen production facilities to this technique. Among the first to harness the advantages of new welding processes in the past, Ryan has been similarly progressive in the use of inert gas-shielded welding. Ryan's 169 fusion welding stations consume more than two million cubic feet of inert gas a year to make it one of the nation's largest users of this process.

Fusion welding is the most versatile and useful tool which modern industry has evolved since the days of the village blacksmith. In countless applications it has replaced fastening by bolts and rivets and made possible new structural designs. This is particularly true in the high temperature products which Ryan builds for jet, rocket and piston engines. Here, the hurricane of heat which they must endure requires that they be as homogeneous as possible. Also, the supersonic flows of fluid through them demand smooth projection-free surfaces to avoid the incidence of turbulence and drag. Inert gas-shielded arc welding incorporates the

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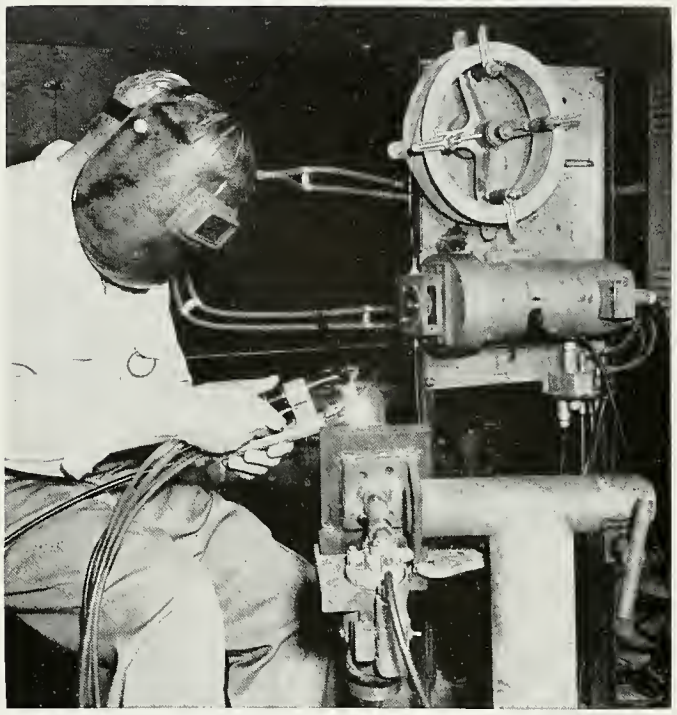
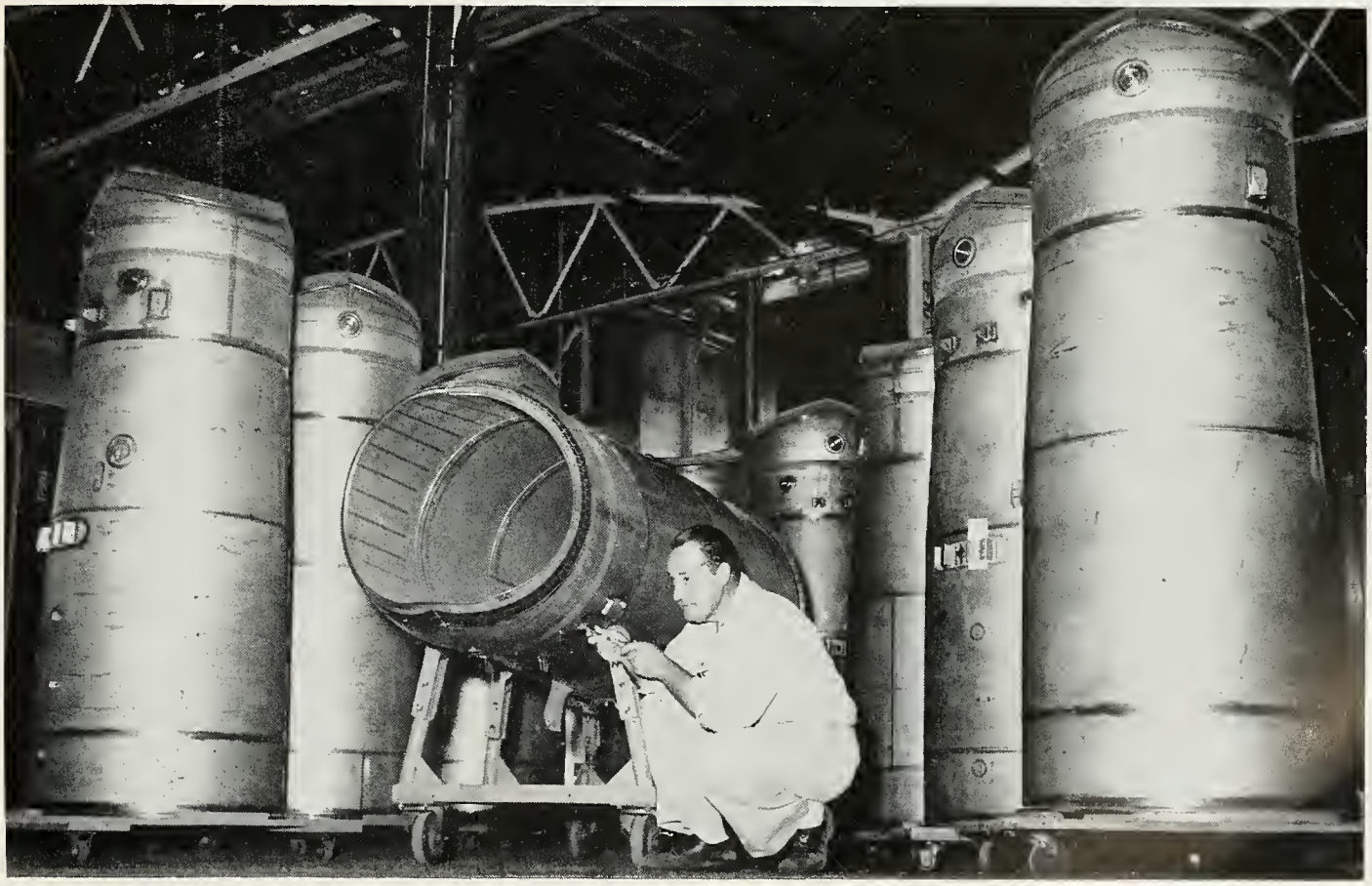
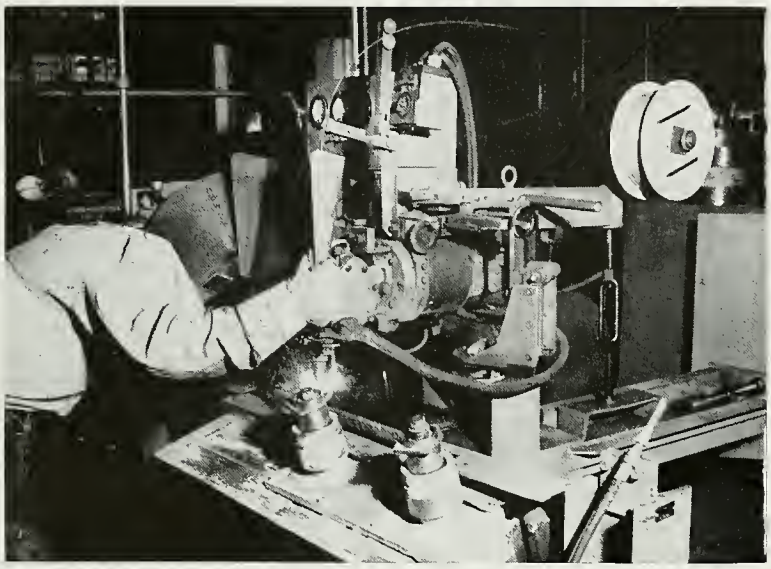


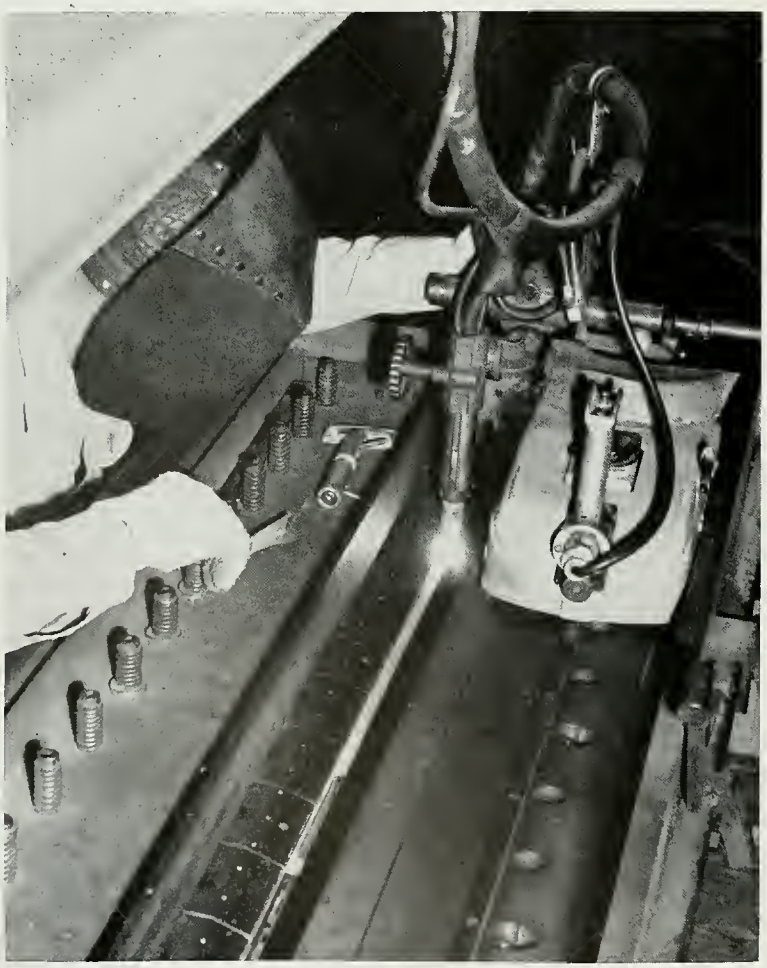
Motor-driven rolls feed wire into the arc in this new Linde method which Claude Coppock uses to weld Ryan exhaust parts.

Mammoth "flame throwers" for G-E jet engines, these Ryan-built afterburners are Heliarc-welded into smooth barrels of Inconel W.





An electronic "eye" calls "time" on Ryan's new Sigma welding machine which has squeezed a nipple welding job from 3 minutes to 7 seconds. Lloyd Jenkins is busy keeping up with machine's fast-shift carriage.



Speeding at 30 inches a minute, an automatic Heliarc machine fuses the seam of a stainless steel tail-pipe for a G-E jet engine. Ryan uses automatic Heliarc, and special fixtures, for straight-line work.

advantages of other types of fusion welding and permits the joining of many high temperature "super alloys" which could not otherwise be fabricated.

New developments in this field have been so numerous that it might be well to unscramble some of the confusion which may exist in the layman's mind. There are five basic types of shielded arc welding in general use. These are: (1) Inert gas-shielded tungsten arc welding, popularly called "Heliarc," (2) Inert gas-shielded metal arc welding, called "Sigma," (3) Submerged arc welding, also called "Unionmelt," (4) Atomic hydrogen welding and (5) Coated electrode arc welding.

All of these methods employ the use of a shielding agent, either gas or solid, to protect the hot electrode and weld metals from the oxidizing effects of the atmosphere. While this oxidation can be tolerated in many industrial welding applications, it is thoroughly undesirable in aircraft structures. In jet, rocket and piston engine part, oxidation produces a brittle, porous structure with reduced strength and corrosion resistance. Continually subjected to cyclic extremes in heating and cooling, these components must be joined by top quality welds. Similarly, aluminum and magnesium alloy structures must be shielded from oxidation when welded or the hard oxide film which forms will prevent the heating and joining of the metal.

INERT GAS-SHIELDED TUNGSTEN ARC WELDING

Developed at the General Electric Company by Hobart and Devers, inert gas-shielded tungsten arc welding—Heliarc—is similar to atomic hydrogen welding in that it makes use of a gas for protecting the hot metal. Unlike the atomic hydrogen process, the arc is maintained between a single tungsten electrode and the base metal instead of between two electrodes. Also, the blanketing gas, which flows in a low velocity stream around the electrode, consists of an inert, monatomic gas rather than hydrogen. This gas serves only as a shielding agent and does not dissociate to release additional heat as hydrogen does.

The heliarc arc is quiet and the tungsten electrode consumption is extremely low. Filler rod may be added by simply feeding wire into the arc. Both AC and DC systems are used depending upon the materials being joined. Argon and helium-shielded tungsten displays a marked polarity, or rectifying quality. When used with DC current, this causes unequal heating at the two ends of the

arc. With straight polarity, the electrode operates cool and the work is hot, which is desirable for most metals. For use with aluminum, magnesium or beryllium-copper alloys, however, reverse polarity must be employed, in which the electrode is positive and operates hot with the work cooler.

The outstanding advantages of Heliarc welding are elimination of flux, increased speed, improved quality and minimized weld finishing. By eliminating the need for flux, Heliarc provided the first successful means for fusion welding aluminum and magnesium alloys, which are attacked by the corrosive elements of fluxes. Without flux, flux entrapment is avoided. This permitted much more latitude in welding design because some joints are certain to entrap flux and often its removal is impossible. Ryan employs Heliarc to weld tee, lap and edge joints which were formerly regarded as impractical to attempt because of flux removal problems.

Heliarc is fast. Full penetration with speeds as high as 40 inches per minute can be attained on 1/16" stock. The pinpoint concentration of heat which Heliarc provides, coupled with its speed, makes it exceptionally useful for welding the stainless steels which Ryan fabricates. These alloys are subject to carbide precipitation and loss of corrosion resistance when exposed to sustained welding temperatures. Also, the stabilizing elements of columbium and titanium, contained in stabilized grades of stainless steel, may be boiled away if metals are held at welding temperatures for prolonged periods.

Undoubtedly, Heliarc's narrow band and high speed heating characteristics have made possible the welding of the "super alloys," used in jet engines. Inconel X and W, Stellite 25 and N-155 are extremely susceptible to cracks at welding temperatures because of their

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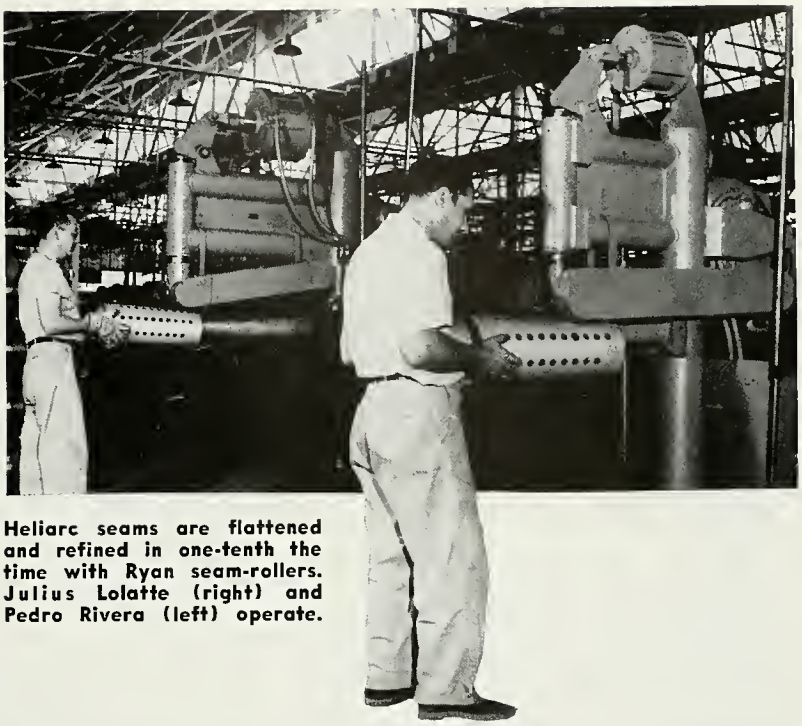
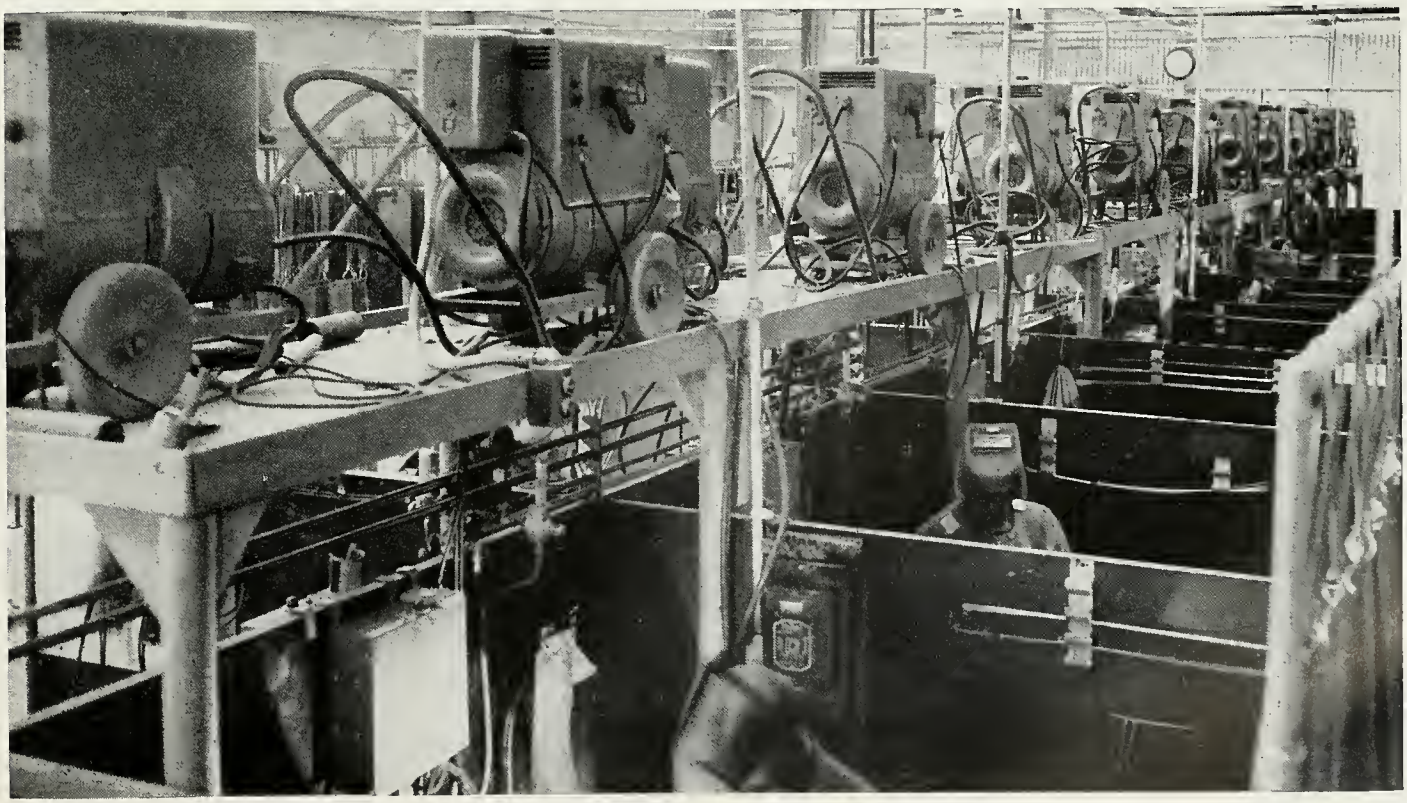


Heliarc seams are flattened and refined in one-tenth the time with Ryan seam-rollers. Julius Lolatte (right) and Pedro Rivera (left) operate.

Ryan's 29-booth Heliarc flange-welding department, with overhead machines and automatic controls, is most modern in the industry.



External fuel tanks, shown affixed to wings of Boeing KC-97G Stratofreighter, will provide this plane increased range. Ryan is producing tanks in $2,000,000 orders.

ONE of the world's most versatile planes, the Boeing KC-97 Stratofreighter, is being equipped with unusually designed external fuel tanks to extend its range and give it even greater utility than it already has.

These streamlined aluminum wing tanks, now in production at Ryan Aeronautical Company under contracts exceeding $2,000,000, are fabricated primarily with the use of resistance welding, in which field Ryan has been the established pioneer in the aircraft industry.

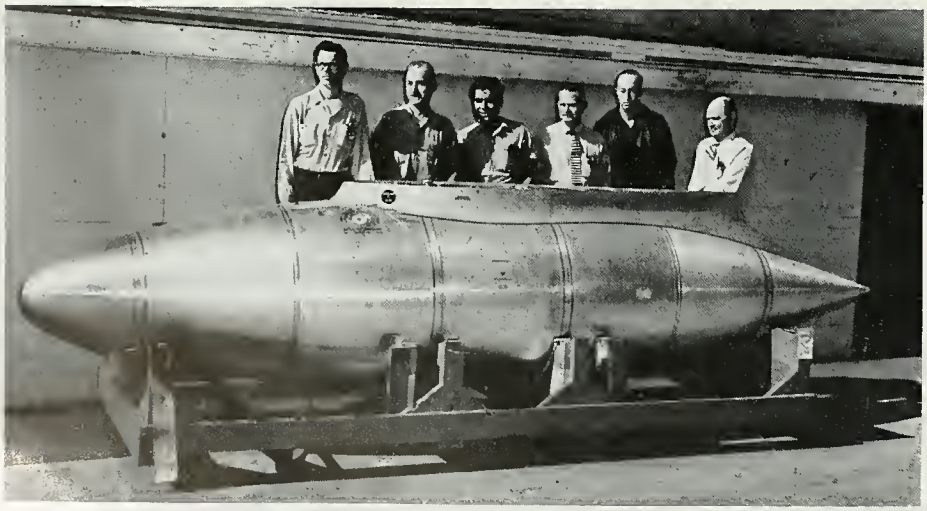
This method of fabrication was given extensive application on huge fuel tanks which Ryan has been building for the Boeing B-47B all-jet bomber for more than two years. These tanks, the largest of their kind in the world, employ more than 30,000 electric spot welds, and the giant torpedo-shaped structures are made leak-proof by welding alone. Hundreds of such tanks have been delivered.

The KC-97 tanks are somewhat smaller than their predecessors. Both types have very few component parts, with no longitudinal members and few bulkheads.

Deliveries of the new tanks, whose capacity has not been disclosed, are scheduled over the next two years. They will accommodate a supplemental supply to that carried in the internal fuel cells, and will be installed beneath the wings of the combination cargo-tanker planes.

TANKS FOR TANKERS

New wing tanks provide even greater utility to Boeing KC-97s



First of new Ryan fuel tanks is pictured with key men in the project. Left to right, Stan Bojens, Howard Bianchi, Bruno Garcia, Ray House, Gordon Longmire, Dick Wells.

In the B-47B bomber, technicians at MacDill Air Force Base in Florida have found a novel use for the external tanks. With only slight modification, the technicians discovered that the tanks, when not needed for fuel, can be converted into cargo carriers. Two access doors were cut in the side of a tank, and plywood flooring and tie-down rings were installed.

The newest models of the 350-mile an hour Stratofreighter, the KC-97G, are being delivered to flying tanker squadrons of the Strategic Air Command from Boeing's Renton, Wash., plant. More versatile than ever, they are equipped to serve as Flying Boom aerial refueling tankers as well as multi-purpose cargo, personnel and hospital air evacuation transports.

This is the 11th model of the famed

(Continued on Page 24)

RYAN HIGH-SPEED TARGETS TO HELP TRAIN GUN, GUIDED MISSILE CREWS

Army Ordnance orders remote-controlled 'Firebees'

HIGH-SPEED aerial targets have been ordered from the Ryan Aeronautical Company by Army Ordnance to aid in training Army troops in the operation of the Skysweeper gun and the Nike and other guided missiles. it has just been revealed by the Los Angeles Ordnance District.

The new Ryan Firebee targets, which fly at almost the speed of sound, are remotely controlled from the ground and can maneuver, at varying speeds and altitudes, over anti-aircraft installations—simulating invading enemy aircraft. In this way, ground troops gain the experience of operating anti-aircraft guns and guided missiles under near-combat conditions.

Officially designed the XM21, the new air target looks like a "pint size" fighter plane. It has swept-back mid wings and tail surfaces and is approximately 12 feet wide and 18 feet long. It will weigh about 1800 pounds. The design incorporates a two-stage parachute recovery system to lower each target without damage after a target run. It is powered by a Fairchild J-44 jet engine.

The Firebee target is ground launched from a platform with the aid of a rocket to catapult it to flying speed. A second or two after launching, the jet engine takes over as the sole source of power and the rocket is jettisoned.

A development contract under the joint auspices of the Army, Navy and Air Force was placed with Ryan Aeronautical Company prior to Korea. Early this year, Army Ordnance placed the first military production contract for the targets. Delivery is expected later this year. The targets will be shipped to Ordnance's White Sands Proving Ground in New Mexico, and Fort Bliss, Texas, where they will be put into operation. In addition, they will be used for studying the capabilities of high altitude targets in the high speed class.

Ryan engineers will supervise the technical and operation phases of the program at both Army installations.

CROSSING NEW FRONTIERS

Ryan's engineers keep pace with swift aviation progress

ADVENTURES across new frontiers of aviation knowledge are being performed by a rapidly increasing number of Ryanites whose work is expected to yield exciting results as projects now in the plant are pushed forward.

The "adventurers" are members of Ryan's engineering department, now in the midst of its biggest expansion since World War II. During the past eight months, the department has had a 50 percent gain in personnel, and by the end of this fiscal year, Oct. 31, employment will exceed 400.

Coincidental with the increase in numbers has been a growth in the technical skills represented by engineering personnel, according to Bruce Smith, director of engineering. Supplementing the professional adeptness of the old-timers in the department, many recently employed engineers have come to Ryan from topflight posts in other aircraft companies or from duty with the Air Force and Navy at Wright Field and Washington, D.C. The latter either decided to resume their civilian careers by taking jobs at Ryan after their service in the armed forces ended, or were on civilian duty with the military and decided to join a private contractor.

Typical of this group is Robert A. Fuhrman, recently appointed assistant to Peter F. Girard, chief aerodynamics engineer and test pilot for Ryan. Fuhrman was a civilian aerodynamics instructor at the famed Navy Test Pilot School at Patuxent River, Md., which is described elsewhere in this issue of the Ryan Reporter. He holds an aeronautical engineering degree from the University of Michigan and a masters' degree from the University of Maryland.

One of the sections of engineering where activity has been most intense is electronics, under Owen S. Olds. This group has doubled its work, from 5,000 to 10,000 man hours monthly, reflecting Ryan's rapidly growing interest in that field. Important projects, details of which remain restricted, are shaping up in the

(Continued on Page 24)

On the drawing boards and desks of these engineers, challenging new aviation concepts are being worked out at Ryan Aeronautical

Ryan chemical research is spearheaded by chief chemist Bernard Floersch who keys staff's efforts to factory needs.

ATOMS IN HARNESS

Ryan production lines sprout from a tiny test tube

CHEMISTS have concocted a new liquid fuel for rockets which burns at the sizzling temperature of 6800°F. Called "diborane-oxygen," the flames from this crackling mixture are hotter than the melting point of any known metal.

Dramatic revelations of this kind are sure to impress the everyday reader with the key role which chemistry plays in aeronautical development. But few are aware of the solid, day-by-day contributions which chemists make to further the aviation industry's advance. That's because these achievements are imperceptably woven with the threads of production and engineering in the manufacturing fabric.

At Ryan, the chemical laboratory is vitally important to almost all phases of production. Headed by Chief Chemist Bernard Floersch, P.E. it is charged with the task of providing every chemical process required to make Ryan products. This covers a myriad of things including acid pickling baths, welding fluxes, heat treating systems, furnace atmospheres, anodizing, cleaning, painting, electroplating, degreasing, lubricating, corrosion control, molten salt baths, adhesives and plastics, to mention a few.

It embraces a continual investigation of the properties and behavior of new metals such as titanium and the jet "super alloys." Designed to determine their effectiveness under severe service and their adaptability to production, these evaluations are often made for the Armed Forces as well as the metal-producing mills. Ryan is currently using 21 different high temperature alloys to build jet,

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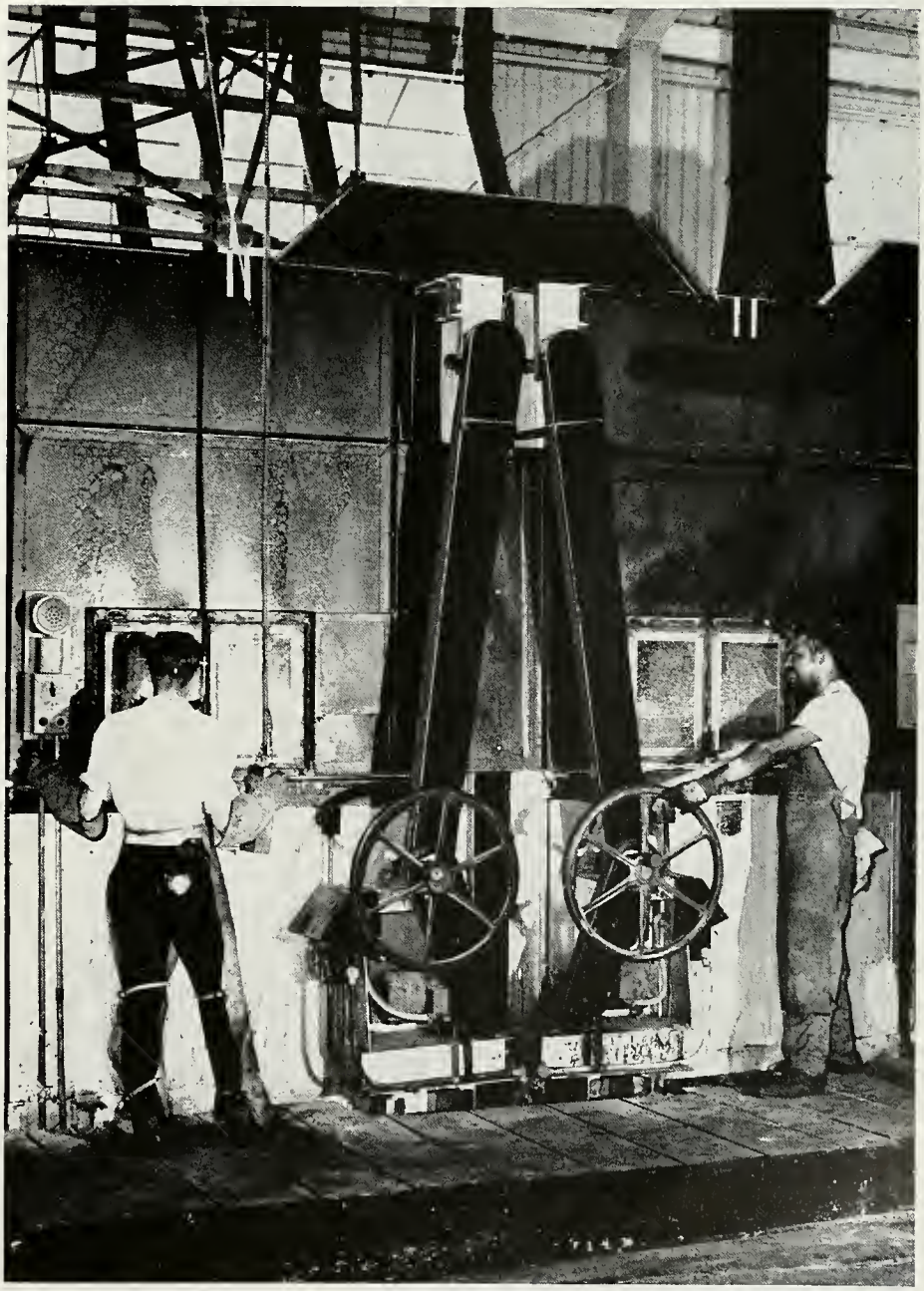


Three new RACO compounds were devised by Ryan chemical research to serve this fast, multi-purpose pickling bath which descales most stainless alloys within few minutes.

With RACO 203, Ryan saves $30,000 yearly using water-soluble oil as lubricant on hammer-formed parts. Clifford Crist operates 7,000-pound Cecostamp hammer.

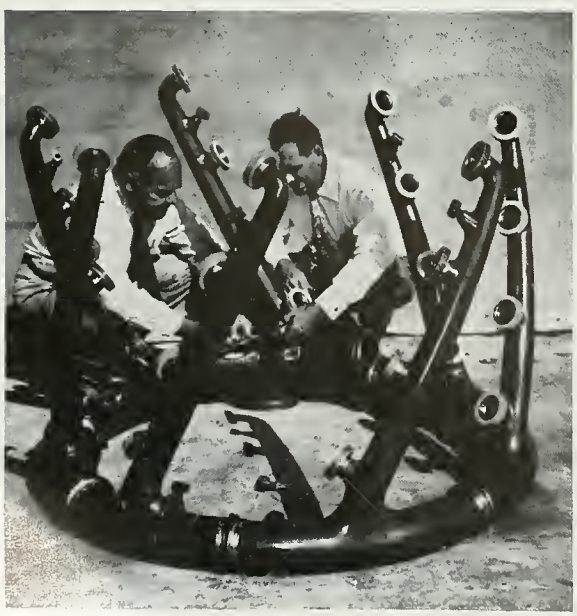
rocket and piston engine components. For many of these, new manufacturing techniques had to be developed by the chemical laboratory before they could be placed in production.

The Ryan chemical laboratory is part of the engineering department. In this connection the group develops process specifications included in Ryan proposals for new aircraft and other products. For instance, in Ryan's new high speed jet target plane, the Firebee, the magnesium surfaces were rendered impervious to salt water corrosion by a special process which the chemical laboratory devised.

For the electronics research section at Ryan, the chemical laboratory has produced extremely accurate wave guides which could not be made in any other fashion. These are produced by electroforming in the laboratory. The group developed a new technique of stress-free electroplating which produces a sound-"dead" guide that is entirely free of residual stresses. Since the part cannot be heat treated, this is a major advantage because it can be silver-soldered without exhibiting the slightest tendency toward warping.

RACO COMPOUNDS

So many new compounds have been developed by the Ryan chemical laboratory that a classified list has been compiled to keep track of them. Called "RACO" compounds, more than 50 of these substances are currently used in Ryan production and a substantial number of them are being patented. The RACO compounds fall into three categories: (1) those which save time, cut cost and reduce labor in the building of Ryan parts,



(Left) Furnace scale is removed from these huge 310 stainless exhaust systems with a Ryan RACO compound. Lab director William Cockrell and engineer Ted Hacker examine. (Right) Ryan chemist Al Coha shows typical wave guides produced in chemical lab for electronics research. Electroforming with stress-free technique is secret of success.

(2) those which accomplish a production process not possible with commercially-available compounds and (3) those which are conceived as the sole means for fabricating a specific component.

19-9DL DESCALER

A striking example of RACO compounds which fall into the first category are those associated with Ryan's unique multi-purpose pickling bath system. This facility was created when Ryan production faced a nasty problem caused by the introduction of 19-9DL stainless steel and Inconel into exhaust systems. When 19-9DL was welded, it formed heat-affected zones along the weld seams which were unduly attacked by the standard hot nitric-hydrofluoric acid bath used to remove the scale formed in heat treating furnaces. Another obstacle was the fact that the acid pickling bath would remove only half of the scale formed on Inconel parts although it was eminently successful when employed with the 18-8 types of stainless steel.

To overcome these obstacles, a new pickling procedure had to be devised. If possible, the system should also be effective with the stainless steels and Inconel in order to save space and extra handling. Bernard Floersch and his staff attacked the problem from its basic elements. Their study of the iron salts produced by the hot nitric-hydrofluoric acid bath showed that the acid digestion of the salts and the severe attack on the metals were closely associated with the production of divalent and trivalent iron. The core of the problem evolved about whether the chemical reaction involved was oxidizing or reducing in its effect.

Michael Mullins immerses a fuel tank section in bath of RACO 034 which removes oxides prior to spotwelding. Solution cleans 61S to zero microhms in minutes.

From these investigations and a goodly amount of experiment, three new RACO compounds, Nos. 006, 009 and 010, and a five-tank pickling system were developed. This system descales all of the alloys used, Inconel, 19-9DL and the 18-8 stainless steels and performs the task in a brief period with a compact facility. The first two tanks contain the same molten caustic salt, divided to maintain bath temperature during continued immersions. The third tank is a cold water quench tank. The last two tanks contain cold acids.

The exhaust system parts are dipped in the molten salt for six minutes, quenched in cold water, given a five minute acid bath followed by 15 to 20 minutes in the second acid. Then they are dipped in cool water and rinsed off to emerge bright and clean. The new procedure has completely solved the acid attack problem, standardized on a single system for all alloys and reduced pickling costs by 80 percent.

Tough Inconel flame ducts for G-E jets are formed with RACO 300, a dry lube of controlled drag. Bill Barnes inspects.

SOLUBLE OIL REMOVER

With RACO 203, Ryan was able to convert the system of lubricating and degreasing stainless steel parts and realize substantial savings in costs and production time. Prior to forming in drophammers, exhaust system parts were brushed with heavy forming oil to lubricate metal flow

(Continued on Page 20)

"LITTLE INCH" FOR ARGON

FIRST in the west, Ryan's new argon gas storage and distribution system will save thousands of dollars a month by reducing gas costs, eliminating lost welding time and avoiding all gas bottle handling.

The unique new system is a 52,000 cubic feet storage facility composed of 186 steel cylinders manifolded together in three banks and installed by the Linde Air Products Company. From these, Ryan has installed a network of 3800 feet of extra heavy steel piping to feed the argon gas to every inert gas-shielded arc welding booth in all factory buildings.

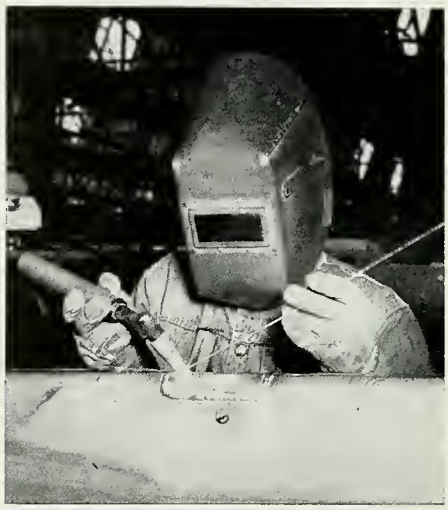
Probably the nation's largest consumer of argon, Ryan uses almost $200,000 worth every year. Jet and rocket engines, fuel tanks, exhaust system and aircraft structures are "stitched" together with the help of this inert gas.

Before the new installation was made, the 85 inert gas welding stations at Ryan had to be served with individual argon gas cylinders. This presented a number of disadvantages compared with the new central storage system. For instance, each welding booth was subject to gas depletion every time the gas pressure in a cylinder dropped to 25 p.s.i.

This required a replacement service in which a full cylinder was brought to the station and installed. On each occasion, the depleted bottle had to be disconnected, the gauge removed and attached to the full bottle, the line blown to remove dust and the new bottle attached.

During this procedure, welding was interrupted and valuable production time lost. It is estimated that each cylinder replacement cost between $1.25 and $1.50 for labor alone without taking lost production or gas costs into account.

Another item of cost incurred was the value of residual argon left in each cylinder. Bottles could not be totally emptied but had to be replaced while they still contained 25 p.s.i. of gas. This practice, used to prevent contamination of the bottles by air, resulted in loss to welding use of quantities of gas.



Typical use of argon is fluxless welding af aluminum structure. A blanket af gas shields both electrade and molten metal.

In order to provide a ready supply

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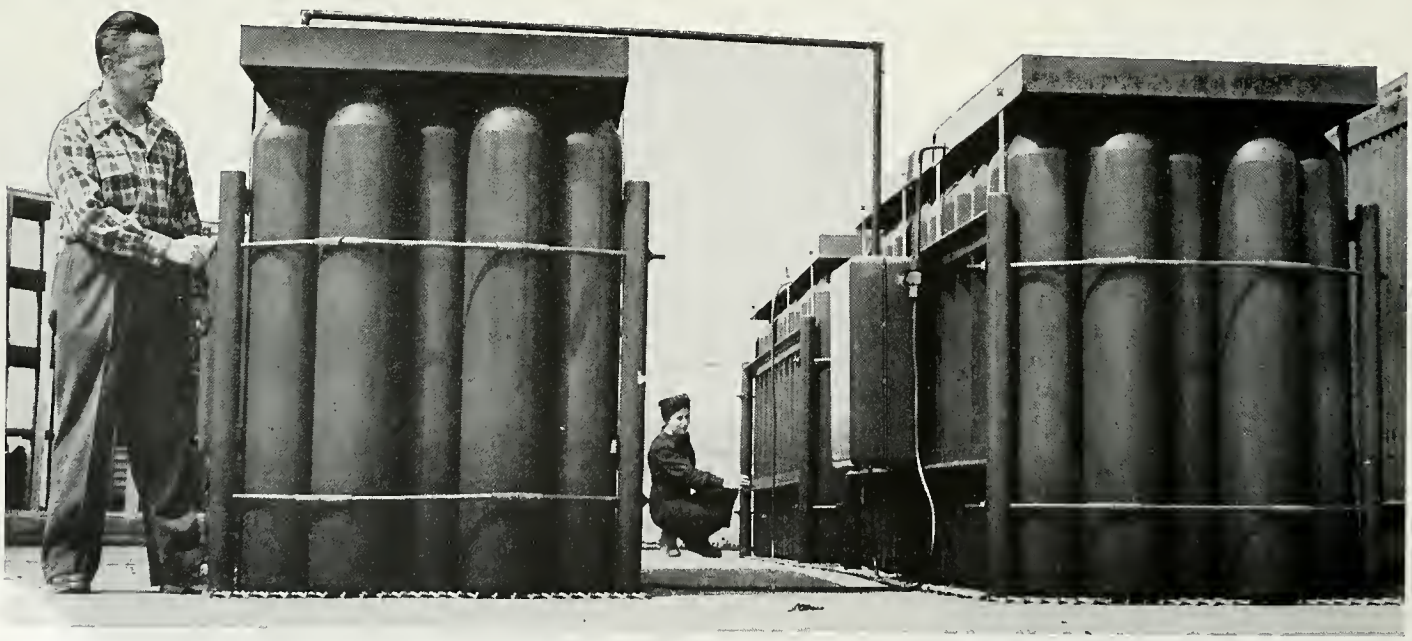
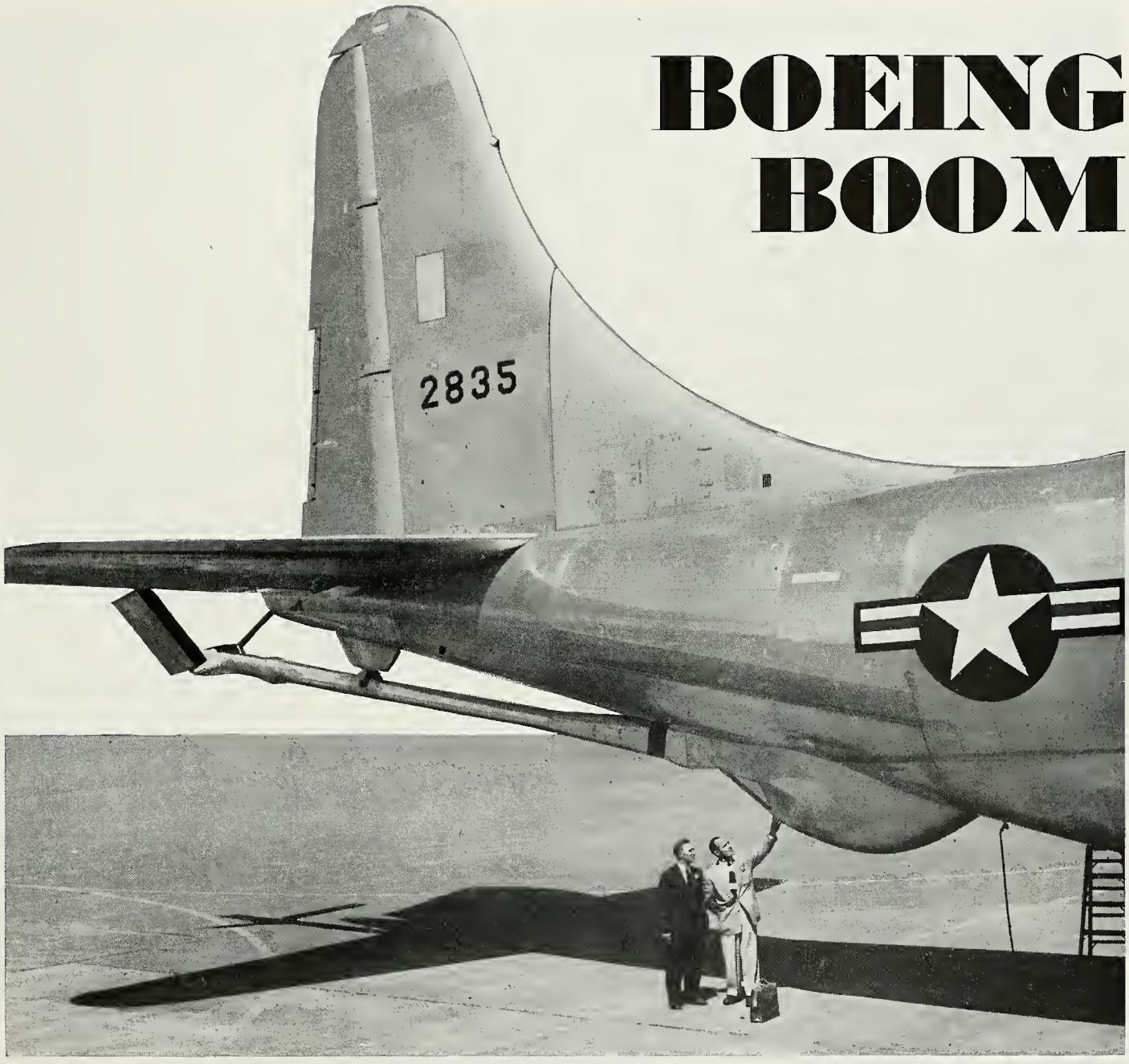
Gas bank pays high percent dividends in money and service



Snug and safe, outside factory walls, Ryan's argon gas "well" feeds 85 inert gas welding stations inside plant through 3800 feet af steel pipe. William Walter (left) and Aftan Church check storage system which has eliminated welding shortages and shutdowns.

BOEING BOOM



Towering 38 feet over their heads, the Stratofreighter's tail dwarfs James Mueller, of Boeing (left) and John Cameron, of Ryan.

IMAGINE a bomber 325 miles long! That's the distance it would take to line up the 17,000 four-engined bombers which Boeing has built if they were snugly placed nose to tail. And, in addition, Boeing has built and flown more jet-engined bombers than any other company in the world.

Yes, Boeing mean big planes. Boeing's reputation is based on a tradition for building big planes which stretches back to the famous B-17s. This mighty weapon came into being in 1932 when Boeing conceived the idea of an aerial dreadnaught that could tote a ton of bombs. World War II proved the potency of this idea when thousands of B-17 Flying Fortresses beat their way to and from German targets.

Next came the B-29 Superfort—the first strategic bomber which could operate independently of escort protection and with sufficient range to strike deep into Japanese territory.

The third great Boeing plane in this series is the B-50 Superfort. In February of this year the last big B-50 left Boeing's production lines and headed south to Mather Air Force Base at Sacramento,

(Continued on Next Page)

Paul Bunyan would blink at these planes from the Northwest

Ryan has stepped up number of aft fuselages for KC-97 Stratofreighters by 90 percent in recent months. Louise Homes and John Choma add final touches on assembly lines.

California. Thus ended a great parade of bombers which overlapped the production of the Boeing B-47 and B-52 jet-powered bombers of today.

Bridging this transition, and extending right into the future with undiminished volume, is the versatile KC-97 Stratofreighter. This capacious 14,000 horsepower cargo-tanker teammate of the B-50 has twice the cargo capacity of a railroad boxcar. It can carry 131 fully-equipped troops, 79 litter patients or 30 tons of freight. It was designed to provide the Air Force with airlift facility which could keep pace with the accelerated speeds of modern bombers.

Today, Boeing is busy building Stratofreighters in large volume and Ryan has stepped up production of components, which are built in San Diego for these airplanes.

Thus the useful life of the rugged Stratofreighter, conceived shortly after the B-29, has not been terminated by the Jet bomber age but actually extended because of it. Thereby hangs a tale which began to unwind in February, 1949.

That was when Major James Gallagher flew a B-50 called "Lucky Lady II"

Cocooned with a protective coating, huge Ryan fuselage sections are loaded aboard railroad flatcars for their 1500-mile journey to Seattle. Upon arrival at Boeing (upper right) they are shunted into the receiving area and prepared for assembly.

The versatile Boeing Stratofreighter has a tail of two cities

Rounding the curve of the unique Boeing assembly line, KC-97 Stratofreighters pass a group of Pratt and Whitney R-4360 engines, equipped with Ryan exhaust systems.

around the world in 94 hours without tagging a terrestrial base. Secret of this 23,452-mile hop was aerial refueling. Four times along the way, the "Lucky Lady II" was met by four "flying service stations" which pumped her depleted fuel tanks full.

Fast jet bombers have emphasized the need for aerial refueling because jets gulp fuel faster than piston-engined planes. A fair estimate of their healthy appetite is 900 gallons an hour per engine, at low altitudes, or a gallon a second for a four-engined job. As a result, Boeing has developed the Stratofreighter into a dual purpose airplane. Within a few hours the C-97 cargo version can be converted into a KC-97 aerial tanker which literally replenishes the range of other aircraft in flight.

Anyone peeking into Boeing's big

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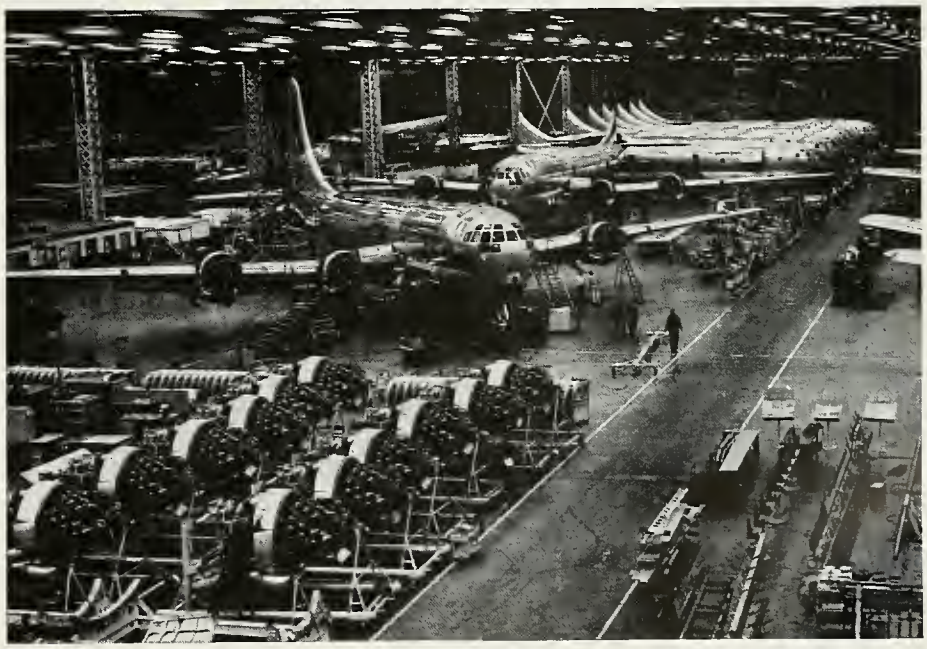


SCHOOL for TEST PILOTS

Pete Girard, Ryan test pilot, learns that Patuxent is one of the world's toughest schools

WHAT is the Navy's toughest and most exclusive school? Talk to a mine warfare expert and he'll give you one answer. A submariner will give you another. But talk to one of the fortunate few aviators who were tapped for the team and he'll tell you that it is the Test Pilot Training School at the Naval Air Test Center, Patuxent, Maryland.

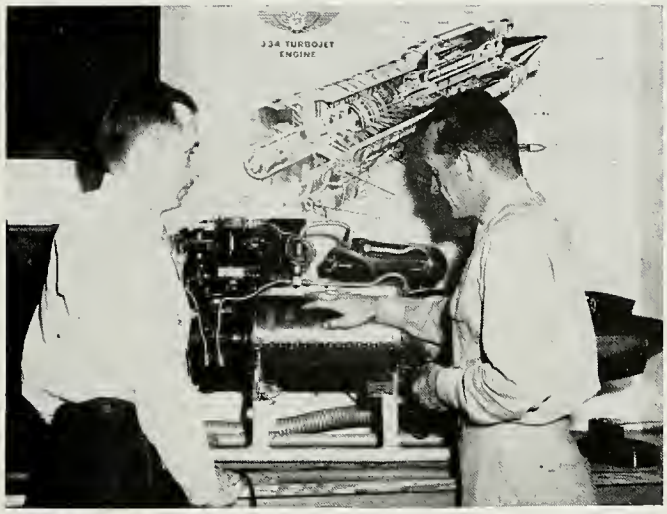
Better yet, ask Pete Girard, Ryan chief aerodynamics engineer who recently completed the rigorous 5½-month course, placing second in the class of 36.

The school, in capsule form, was set up to take specially recommended pilots from operating squadrons of the fleet, brush up their mathematics, rub their noses in aerodynamics, pound proper test procedures in their noggins and at the end of six months have some people who not only fly like hawks but who are capable of objective evaluation of an aircraft's performance and of writing a report thereon that is understandable, comprehensive, and correct.

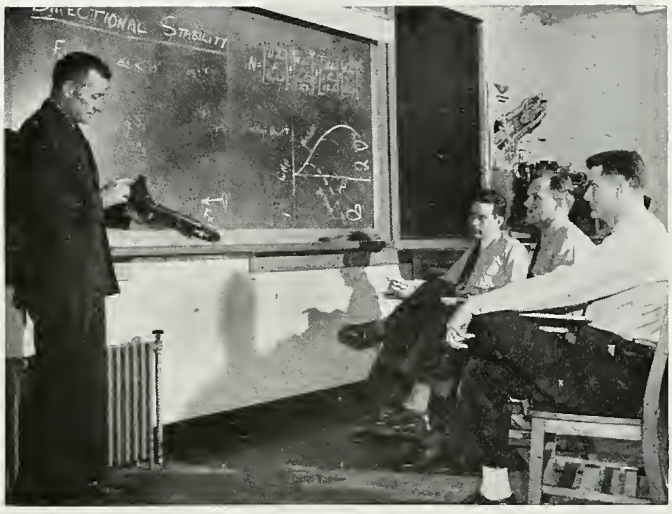
Civilian pilots, also, undergo this training. Their number is limited to highly qualified representatives of aircraft companies, such as Ryan, doing business with the Navy. These fliers learn what is expected of the contractor in testing new planes before they are delivered to Patuxent River. In Girard's class, he was one of only five civilians. The other students were Navy, Marine, Air Force and Coast Guard officer pilots up to the rank of commander and major. Many were combat veterans of Korea.

This is the Naval Air Test Center, Patuxent River, Md., where military and a few civilian pilots undergo rigorous 5½-month instruction in procedures of flight testing.

Four fliers leave the Test Pilot Training Building at Patuxent for the flight line.



Pete Girard, Ryan's chief aerodynamicist, is shown at left as he receives instruction an the J34 turbajet engine from Camdr. J. G. Smith, Test Pilot Training Director at Patuxent.



Comdr. Smith lectures class on directianal stability and control. One af Patuxent's first graduates, he also completed training at the famed Empire Test Pilats' School in England.

by Lieut. Comdr. F. M. (Buzz) Lloyd, Technical Information Officer, Bureau of Aeronautics

The sensitive "seat of the pants" is not the prerequisite of flight testing it was thirty years ago. Problems of extreme temperature variations, shock waves, and flutter incident to speed-of-sound flying demand a more scientific approach. It is because of these complexities that the test pilot training course has become increasingly tougher.

During World War II, it became apparent that the remarkable increase in navigational and engineering complexity had grown beyond the capabilities of the average fleet throttle jockey, so in 1945 a flight test school was organized at the Naval Air Test Center. This was a school for only pilots on duty at the Center, with the purpose of training them in the techniques and fundamentals of performance and stability and control test flying. The school was sort of a part-time affair, but the results were good—so good that the wheels at the Test Center said "Let's have more of it—let's really do a job on these people—let's cut out this part-time business." Thus, in 1948 the Test Pilot Training Division got rolling in high gear. Ten classes have completed their instruction to date.

For a Navy pilot to be selected for the school is a distinction in itself. The classes are small—usually around 25-35 students.

The Navy screening process for likely students is probably ten times tougher than any promotion board and the reason is well stated in the letter outlining the selection procedure: "Opinions and observations being made today by project pilots will be directly reflected in the quality and tactical suitability of aircraft used by the fleet during the next five or more years. The Navy cannot afford to have any less than the best qualified pilots in naval aviation to provide these opinions and observations."

The nominees have to be hot shots to begin with. They have to have a good

(Continued on Page 25)

Pete Girard is pictured in Martin P4M, ane af many planes he flew at Patuxent.

Student pilat and plane captain are inspecting the phato panel of F9F Grumman Panther jet preparatory ta making test flight. The raw panel data are reduced the next day.

From a Ryan-built loading rack, tubes of stainless steel are fed into the Campbell abrasive wheel cutting machine by Hobart Keck.

ABRASIVE TUBE-CUTTER

Ryan saws tubes faster with a spinning wheel

Typical tube lengths used in production are shown by Gerald Potter, methods engineer. All are cut from 20-foot sections.

WITH a new abrasive-wheel cutting machine Ryan is slicing $32,000 a year from tube cutting costs. Burning through stainless steel at twice the speed of standard cutting tools, the new device was developed by the Campbell Machine Company of Bridgeport, Connecticut.

Ryan uses thousands of short pieces of stainless steel tubing each month in ball-and-socket joints, nipples and sleeves of exhaust systems. They must be precision-cut from 20-foot long pipe to various lengths running from one to seventeen inches. A wide variety of diameters and wall thicknesses are used but the bulk of the production is cut from diameters of $2\frac{3}{8}$" with .065" wall thickness.

For a number of years Ryan has cut these tubes with tube cutting lathes. The 20-foot lengths of pipe were clamped in a chuck and rotated against high speed cutting tools. All operations, including clamping, feeding, cutting and removal were accomplished manually.

After cutting, the tubes had to be deburred, individually, by means of a machine which inserted a three-pronged cutting tool within each tube and rotated it. Using this procedure, it required four employees and four machines to produce 1000 finished tubes within an 8-hour shift. With only one new

(Continued on Next Page)

Campbell machine, Ryan can produce 1000 finished tubes in an 8-hour shift. Only one operator plus a few minutes of time from a second employee is necessary.

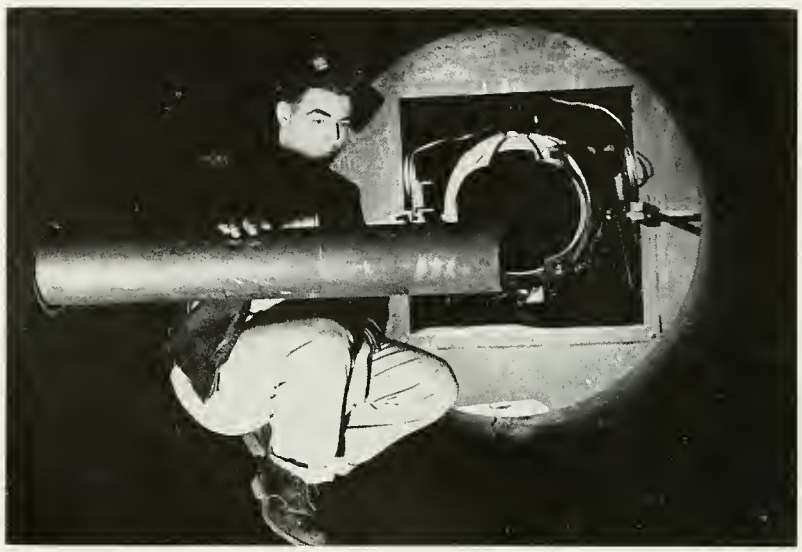
Instead of a steel cutting tool, the Campbell machine employs a 20-inch diameter abrasive wheel which is 1/8" thick. Spinning at high speed this wheel literally burns its way through the tough stainless steel tubes in one second. A flood of coolant is sprayed into the cutting area by means of a motor-driven pump system. The coolant removes heat and residue from the cutting area. Care is taken to direct equal amounts of coolant to both sides of the abrasive wheel in order that an even temperature is maintained to prolong wheel life.

Clamping and cutting action of the machine is accomplished hydraulically. All the operator has to do is feed the pipe into the machine and depress a lever. The lever brings the clamps down on the pipe to hold it rigidly in place. This is followed by the automatic action of the spinning abrasive wheel which comes down to slice through the tube. When the operator raises the lever, the process is reversed. The wheel is entirely free of the tube before the clamps are released so that the wheel does not drag the tube with it.

The burr produced by this type of cutting is a burned, brittle burr which can be removed by tumbling. The tubes are taken to Ryan's Roto-Finish department and tumbled with prescribed abrasives and solutions. In approximately four hours they emerge bright and burr-free. The only employee time required for this operation is that taken to load and unload the tumbling machines which hold several hundred parts. This work is done by air hoists. Ryan estimates that deburring these tubes by tumbling costs two cents per tube contrasted with eight cents per tube under former methods.

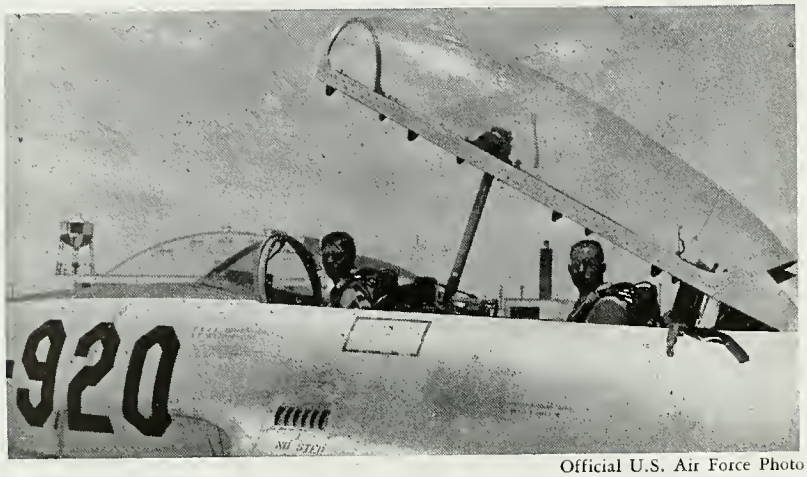
Ryan production engineers have designed and built a special loading rack which attaches to the Campbell machine and holds a half-dozen 20-foot tubes ready for feeding. Also, an ejection mechanism has been installed in order that each cut tube can be automatically ejected into a box.

Fitted with a micrometer type work stop, the new machine is extremely accurate and can cut desired lengths within two thousands of an inch. It is powered with four electric motors for cutting, hydraulic system, coolant distribution and oscillating mechanism. The oscillating system causes the wheel to move back and forth across the work at the time of cutting. This movement is desirable in cutting solid rod stock because it produces a smooth-finish cut. Ryan is employing this technique in cutting stainless steel rod to produce jet engine fittings. In tube cutting, however, Ryan has found that wheel life is doubled when the oscillating action is not used and other advantages, such as speed, are not affected.



JET TOOLS

(Above) A "hot periscope" is adjusted by a General Electric technician in the gas turbine test laboratory. Made of stainless steel and water-cooled, this tube is placed in the fiery path of the gases streaming out of jet engines. Note the "eye-lids" of a Ryan-built afterburner framed in the opening. With the periscope, G-E engineers can watch the pattern of burning gases to learn more about their behavior at temperatures up to 3700°F. (Below) a cold shower for hot air. To help silence the deafening noise resulting from the operation of jet engine test stands, General Electric passes the exhaust gases through this water "bath." The water cools the supersonic gases down from 1800°F. to 400°F. before they are channeled into the laboratory's huge Maxim silencers. Actually, jet engines are like fire sirens in that they both are good noise producers and function by passing a stream of air through whirling blades. Cooling reduces the density of the gases which slows their velocity. In this way, the noise can be "drained off" and they "pop" into the open air with less effect.



Official U.S. Air Force Photo

Check Firebee Jet Target Flights

William F. Berry, Ryan's engineering liaison representative in the operational suitability testing program on the "Firebee" jet target, is shown in rear seat of Lockheed T-33 jet chase plane used in observing flights of high speed remote-controlled drone. The intensive program, which will determine suitability of the "Firebee's" use by the Air Force, is being conducted by the Air Proving Grounds command at Holloman Air Development Center, Almagordo, N.M. Pilat of T-33 in abave photo is Lt. Covell, Korean combat veteran who is assistant test officer on the project.

FUSION WELDING

(Continued from Page 3)

poor thermal conductivity and high coefficients of expansion. Normal welding techniques pour heat into these alloys faster than they can conduct it away from the weld zone. As a result, extreme temperature differential is established between the hot and cold portions of the sheet and severe stresses are set up. Heliarc avoids these phenomena because of its speed and narrow zone of heating.

Heliarc is efficient for welding practically all of the commercial metals including aluminum, magnesium, copper, titanium, stainless steels, nickel and cobalt base alloys, carbon steels, cast iron, lead and silver. It produces X-ray quality welds which possess good tensile strength, elongation and impact resistance. Its high speed makes it ideal for welding light gauge materials because it reduces warpage and provides attractive appearing welds. At Ryan, Heliarc is used to weld gauge thicknesses running from .035" to two sheets of .156".

Due to its inherent characteristics and the stabilizing effect of the blanketing gas, the Heliarc weld deposit is laid down in a smooth bead without sputter or splash. Consequently, the weld seldom requires the grinding or finishing operations which are associated with other fusion welding operations. This is a distinct advantage in reducing labor costs and production time.

Ryan rolls all Heliarc butt welds in austenitic steels, which are accomplished without the addition of filler wire, in Ryan-designed seam rollers. Especially built for this work, the machines flatten the weld seam between two steel rolls under heavy pressure. This cold works the weld to refine its structure and eliminates the notch effect caused by the tendency of the metal to sag slightly when molten.

All exhaust systems are fabricated with Heliarc welding at Ryan. Covering about 80 percent of the industry's requirements, these structures serve such prominent aircraft as Douglas DC-6 and C-124 Globemaster II transports, Boeing B-50 Superfortress, C-97 Stratofreighter and 377 Stratocruiser aircraft, Convair 240 and 340 airliners, Piasecki helicopter and Fairchild C-119 "Flying Boxcars." Ryan manifolds are also used on General Patton M-47 and M-48 medium tank engines. These structures are fabricated from Inconel, and stainless steel of 19-9DL, 347, 321 and 310 types. Gauges run from .042" to .095".

Because of the complex, irregular design of these exhaust systems, they are welded manually. Heliarc is well adapted to this work because it involves light weight equipment with some torches weighing only three ounces. For this work Ryan has established one of the most modern welding areas in the aircraft industry with 29 integrated Heliarc welding booths in one location. All motor-generators are installed overhead and a cascade system is used to supply argon gas and cooling water. Gas and water are automatically controlled by Ryan-devised timers.

For these tasks, DC straight polarity current, ranging from 75 to 100 amperes, is used. Material thicknesses vary in the designs and the Ryan welder uses a Mullenbach foot control rheostat to vary the welding voltage as he goes. This allows the welder to attain better control of welding conditions and produce a finer weld result.

Instead of adding filler metal to these welds, an upstanding flange is formed at the seams and melted down by the heat of the Heliarc arc.

Ryan also uses manual Heliarc methods to weld a wide variety of detailed components for General Electric, Westinghouse and Pratt and Whitney jet engines. These run the gamut of special alloys such as Inconel, Inconel X and W, Stellite 25, N-155, Discalloy and the stainless steels. In jet engine work, an added requirement is made. The dimensions of the weld are specified and tolerances in width must be closely controlled.

In addition to the high temperature alloys, Ryan welds many aluminum alloys with manually controlled Heliarc. Typical example of this work is the welding of huge fuel tank rings, 4 feet in diameter. These rings serve as splice joints for the largest external fuel tanks ever built for aircraft. They are fabricated from 61S aluminum alloy. Ryan welds them with high frequency stabilized AC current, using between 75 and 150 amperes, depending upon thicknesses encountered. These gauges vary from .050" to .072". Heliarc torches used are exactly the same as those employed in welding stainless steels.

One of the interesting types of welding which only Heliarc is fitted to accomplish is fusion spot welding. With a special Linde pistol-type torch, Heliarc can be used to make automatically-timed spotwelds which are exceptionally useful in certain production jobs. Because the spotwelds can be accomplished from only one side of the structure, the parts do not need to be removed from jigs but can be spotwelded right in their fixtures. The technique is valuable where several components must be aligned in a precision fixture and spotwelded in place.

Ryan has constructed a mobile machine which incorporates all of the necessary elements for Heliarc spotwelding—DC generators, argon gas supply, 40-gallon

(Continued on Page 19)

water tank and pump. With this device, spotwelding facility can be quickly moved along the production lines to the work. Ryan is using the new machine to spotweld Fairchild C-119B exhaust hoods and machined rings in assembly jigs. After these parts are carefully fitted together and spotwelded, they are seam welded in resistance welding machines. The Heliarc torch produces such a smooth spotweld that no finishing is necessary in order to run these parts between the wheel electrodes of the resistance welders.

In addition to the large amounts of manual Heliarc welding which Ryan performs, substantial quantities of automatic Heliarc are accomplished. Automatic machines are used on all straight line, butt welding jobs, both in aluminum alloys and the stainless steels. For instance, Ryan builds afterburners, tail-pipes and exhaust cones for General Electric J-47 jet engines in this way. These structures are fabricated from stainless steels and other high temperature alloys in thicknesses from .040" to .075". Ryan designs and builds special fixtures to hold the parts in exact alignment while the automatic Heliarc welding head traverses their longitudinal or circumferential seams. DC straight polarity current is used and welding speeds up to 30 inches per minute are attained. A number of machines are equipped with selenium-type rectifiers which convert AC current from the line into DC and eliminate the motor generator.

All of the longitudinal seams in Ryan's huge fuel tanks are welded with automatic Heliarc machines. These large sections are butt-welded with filler wire automatically fed into the seam. The alloy is 61S aluminum and gauge thicknesses run from .051" to .072". With the Airco "floating" head which automatically maintains a constant length arc, it is possible to weld contoured surfaces. Ryan has built such a machine and uses it to weld the irregular contours of afterburner nozzles, automatically.

One of the newest devices, which Ryan is using, is the Linde semiautomatic HWM-1 welder. This is a manually operated Heliarc torch which automatically feeds filler wire into the arc. All the operator has to do is set the current and wire feed and guide the work. When the arc is struck, the wire is automatically fed between rolls into the weld. Its movement propels the torch. Hand welding speeds as high as 80 inches per minute have been reached with this new method. Combining the advantages of manual guidance with automatic control of arc length, wire feed and travel, the technique is excellent for irregular compon-

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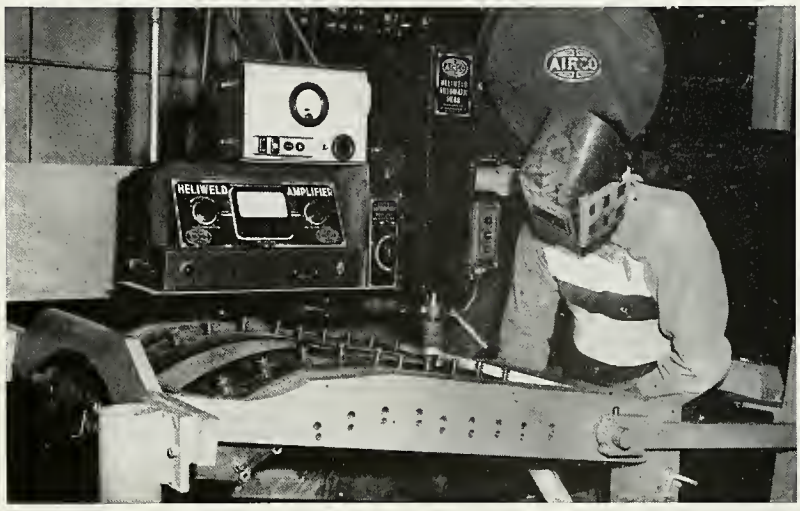


AUTOMATIC CONTOUR WELDER

Newest production tool at Ryan is an automatic welding machine which welds around corners. With unerring accuracy this Ryan assembled equipment makes perfect fusion welds, automatically, over irregular surfaces. The welding electrode follows the "peaks" and "valleys" of the contour with greater precision than human hands could achieve.

In use, the operator simply clamps a large irregular part, such as a stainless steel afterburner nozzle, in the machine, trips a few buttons and the uncanny process begins. A bright electric arc strikes between the tungsten electrode and the work, blanketed by a flow of inert gas which prevents oxidation of the weld seam. The welding head moves horizontally along the seam, fusing the metal and depositing filler wire as it goes. At every irregularity in contour, the electrode head instantly raises or lowers, maintaining a constant arc and making uniformly perfect weld deposits.

In design, the machine is composed of three major assemblies. AIRCO welding equipment is employed to perform the inert gas-shielded welding task. The outstanding feature of this equipment is its floating electrode head. It is electrically controlled to respond immediately to changes in arc voltage. Two small electric motors run continuously to raise or lower the head whenever the arc is lengthened or shortened—which occurs as it passes over irregular contours.

The AIRCO equipment is mounted on a LINDE side-beam carriage which rolls back and forth on bearing rollers attached to a horizontal 12" x ¾" steel plate. By setting a dial for required feed speeds, this mechanism will maintain a precise speed. An electric motor drives the carriage assembly through a gear and rack on the rear of the plate. An electronic control eliminates any variations in speed and assures smooth action.

Ryan plant engineers have mounted both the AIRCO and LINDE equipment on a large steel frame which is attached to threaded steel shafts inserted in steel vertical columns. By push button control, the operator actuates another electric motor which turns the threaded shafts, through a chain drive, to raise or lower the entire assembly. An adjustment of between two and five feet from the floor can be made.

For each production part, Ryan builds a steel holding jig which secures the assembly with pneumatic clamps. These jigs are designed with a counterbalanced side frame, which swings up to allow correct positioning of the part. After the component is welded, a locking member of the jig is opened and the part is pulled out of the end of the jig.

The new machine is being used to step up the production of jet engine parts at Ryan. Such structures as afterburner nozzles and the General Electric D-17 exhaust cones are typical irregular-contoured parts which are welded in the new tool. Welding speeds of as high as 100 inches per minute, three times as fast as manual Heliarc welding, are attained on the new device.

The idea of adapting the AIRCO and LINDE equipment to automatic contour welding of jet engine parts was conceived and outlined by Ray Ortiz, Manifold Production Superintendent. Plans for the machine were developed by C. C. Hasty, Design Engineer.

FUSION WELDING

(Continued from Page 19)

ents. It is water-cooled and capable of handling up to 300 amperes capacity.

Ryan uses a great deal more argon gas than helium in connection with Heliarc welding. Basically, this is because argon can be obtained in higher purity commercially and is more efficient for most of the Heliarc welding tasks. Ten times heavier than helium, argon flows down over the welding better and much less is required to perform a similar welding assignment. Argon arcs have lower voltages than helium arcs and thus permit the use of higher currents without burning the work. Both lower voltage and increased current contribute to improved arc stability. Ryan does use helium, mixed with argon, for all welding of aluminum alloys because the heat of the helium arc is greater for a given current than that of argon and penetration is deeper.

INERT GAS-SHIELDED METAL ARC WELDING

For speed in welding, inert gas-shielded metal arc — Sigma — makes other types look slow. This amazing method has been clocked at 200 inches a minute with 1/16" material. Even in ½" plate, structural welds can be made at 48 inches per minute.

Sigma uses a consumable wire electrode which is fed at high speed through a blanket of argon gas and melted into the weld area. Like Heliarc, it produces high quality welds with deep penetration and lends itself to automatic operation. Sigma welding can handle twice the current densities which are used with Heliarc.

Ryan uses Sigma to weld exhaust system nipples to port flanges and join ball sections to exhaust tubes. These components are about two-and-a-half inches in diameter and are welded circumferentially. For welding the nipples to the flanges Ryan has devised a new machine which is phenomenal in its effectiveness.

The welding unit used is a Linde FSM-1 type powered by a Lincoln 400-A motor-generator. The unit is mounted on a custom-built fixture which incorporates a sliding carriage with two revolving holders that turn at constant speed. Each holder is a small expanding mandrel which firmly retains the nipple during welding and quickly releases it when contracted. The carriage moves back and forth through an 18-inch travel to bring the nipples directly under electrode of the Sigma welder. It is operated by foot pedal control.

The operational sequence goes like this: the operator places a nipple on one of the revolving holders and presses the foot pedal. The carriage shifts to bring the nipple under the electrode. As it moves, the carriage trips a microswitch which starts the welding cycle and the arc strikes. Current used is 250 amperes, reverse polarity DC. The light of the arc plays upon a photoelectric cell which trips a relay that automatically times the welding run and switches off the arc. All the operator has to do is shift the carriage and replace the nipples. With two holders, one nipple is being welded while the other one is being replaced by the operator.

Formerly it required three minutes of manual welding plus finishing to do one of these nipples. With the new machine it takes only 7 seconds to attain a sound, clean weld which requires no cleaning or finishing labor. A normal production for this machine is 800 nipples per 8-hour shift although as many as 1200 have been accomplished in that period. Ryan exhaust system production uses thousands of these stainless steel components and it is quite evident that the new machine has substantially reduced their cost and increased their availability.

SUBMERGED ARC WELDING

The submerged arc welding technique —Unionmelt—is similar to Sigma welding in that it also employs a consumable electrode and permits the use of high current densities. It is different in that the shielding agent is not a gas but consists of dry, granular flux which pours down over the weld area. The arc and weld metal are fully protected from oxidation by this means. The granular flux melts and forms a fused slag which blankets the weld. The material which does not melt is recaptured and used again. The solidified slag is easily removed from the weld.

With Unionmelt there is no arc visible and the operation is quiet and smooth. Because Unionmelt permits the use of higher density currents much larger diameter electrodes can be used and heavier welds laid down in single passes. For this reason, it is used to weld heavy gauge materials and lends itself to straight-away work. Speed is a salient feature of Unionmelt. Automatic machines can weld metals three inches thick in one pass and can attain 200 inches per minute on light gauge materials.

Ryan uses automatic Unionmelt to weld a large heavy-gauge circular burner plate and flange together. This assembly is part of the aft frame, or "backbone," of General Electric J-47 jet engines. The big burner plate is .125" thick and the flange is .075". Both components are fabricated from 321 stainless steel. The work is performed on a specially-built Ryan fixture which is rotated by means of a large Worthington weld positioner. Filler wire of 29-9 composition is added to the weld. Speeds of welding are 55 inches per minute to produce a ⅛" fillet weld in one pass.

Unionmelt is employed to weld stainless steels, carbon steels, monel, inconel, aluminum-bronze, copper-silicon alloys and straight chrome and nickel. Smooth, sound welds can be made at good speeds with 20 pounds of metal per hour deposited.

ATOMS IN HARNESS

(Continued from Page 9)

and reduce wear of the dies. After forming, the parts were degreased in a trichlorethylene vapor unit, to remove the oil, and de-zinced in a nitric acid bath. De-zincing is done to remove particles of zinc picked up from drophammer dies. They cause zinc embrittlement, when the parts are heated, resulting in the formation of cracks. Since Ryan puts 3,000 half-stampings through this system in each 8-hour shift, the costs involved in these processes are an important item.

It was apparent that savings could be made if the parts could be lubricated by a spray system rather than by manual brushing. Also, it appeared that economic advantages would accrue if a water-soluble oil, which could be washed off, were adapted to the process to reduce the use of vapor degreasing which is relatively costly. However, when trial runs of these improved techniques were made, a major snag developed.

First, the water-soluble oil was not removed by the hot water bath. The bath soon became saturated with oil and reapplied it to the parts as they were pulled out. Then a hot alkaline cleaner, for stainless steel, was tried. It, too, failed. Being very caustic, the alkaline cleaner leached the solubilizers out of the oil leaving a coating of non-soluble oil on the parts.

That's where RACO 203 came into the picture. Prescribed by the chemical laboratory, this compound is prepared into a hot bath. It quickly removes all traces of the water-soluble oil and does not reapply it to the parts. Following this treatment, the alkaline cleaner is used to eliminate traces of non-soluble oil which the parts may have picked up from handling or machine drippings. The new system has avoided the need for installing two more vapor degreasing units. It is saving Ryan $30,000 a year in trichlor-

(Continued on Next Page)

ethylene solvent costs alone. Marked savings are also gleaned from the more efficient methods of lubricating and handling the parts which RACO 203 indirectly makes possible.

61S ETCHANT

When Ryan launched production of the largest external fuel tanks ever built for aircraft, another problem in chemistry presented itself. Designed for the Boeing B-47B Stratojet bombers, these huge torpedo-like cells encompassed the most extensive production of 61S aluminum alloy attempted. To make them aerodynamically smooth, 30,000 spotwelds are used in their fabrication. This requirement necessitated the use of the country's largest spotwelding machines and volume production methods for cleaning the aluminum sheets prior to spotwelding.

Most aluminum alloys form a hard glass-like oxide coating within 24 hours of exposure to air. 61S was no exception. But, being an alloy which had not been extensively used in sheet form, there was no commercial cleaner available to do the job which Ryan needed to have done. All available compounds deoxidized the surface in spotty fashion. This was worse than no cleaning.

The oxide film formed exhibits a substantial resistance to the flow of electricity between the electrodes of the spotwelding machines. The big machines have to be set to deliver precise amounts of current in uniform fashion. If the surface resistance varies, due to spotty removal of the oxides, the temperatures generated will also vary. Where the film is cleaned away, resistance will drop and temperatures will be reduced. This causes weak spotwelds because temperatures may be too low to fuse the metal into sound nuggets. Where the film is not removed, resistance will be high and temperatures will soar. This often produces extreme heat and causes holes to be blown in the metal.

The Ryan chemical laboratory met this challenge with RACO 034. This solution cleans the 61S aluminum alloy sheets with remarkable thoroughness. A surface resistance of zero microhms can be obtained in three minutes of immersion. The bath has wide latitude in that immersion times varying from three to twenty minutes will produce the same satisfactory results. The solution can be maintained for periods of six months with only small additions of chemicals.

Air Force requirements demand that the aluminum alloy parts have a surface resistance of less than 50 microhms when spotwelded. For a period of two years Ryan has uniformly maintained the surface resistance of the huge tank sections below 15 microhms, at the machines, with the RACO 034 bath. More than 8,000 square feet of metal are processed in these baths each week.

Material Group Visits Ryan

Top executives in material and purchasing departments of aircraft companies toured the Ryan plant recently, following a meeting in San Diego of the Aircraft Industries Association's west coast material committee.

They accepted the invitation of M. K. Smith, Ryan director of materiel and member of the committee. Ryan executives served as guides on the tour of plant facilities. Afterward, the group assembled in the company cafeteria for refreshments and to discuss their observations. William Brotherton, of Ryan public relations, outlined the company's current activities.

Ryan personnel serving as tour guides were Robert Clark, Jack Zippwald, C. R. Foushee, Jr., William Sloan, Ralph Flanders, Darwin Whetstine, Robert Chase, and Ed Meripol, representing virtually all phases of plant activities.

Among the visitors were J. L. Wells and H. C. McDonald of Lockheed, Milt Taylor and S. H. Bellue of Hughes, Howard Golem of Convair, James Meyer of AiResearch,

Other A.I.A. visitors included J. L. Wells, of Lockheed; James Meyer, of AiResearch, and Howard Golem, of Convair, escorted by Robert Clark (right), Ryan methods engineering manager.

Roy Peabody of Aerojet, John Coleman of Bendix, R. G. Francis of Marquardt, R. W. Brick of Solar, Clyde Seymour of Solar and J. R. Bachman of the A.I.A.

Examining fabrication methods in the Ryan plant recently were members of the A.I.A. material committee. Jack Zippwald (second from left), customer service superintendent, and Ed Meripol (right), field and sales representative, Ryan Los Angeles office, were guides for one of the groups. In photo are Roy Peabody, of Aerojet; R. G. Francis, of Marquardt; and H. C. McDonald, of Lockheed.

310 OXIDE-CONVERTER

When Ryan began production on exhaust systems for the Pratt and Whitney R-4360 engines the chemical laboratory again solved a tough production problem. Designed by Pratt and Whitney, the new exhaust system incorporates a number of innovations. They are the largest stainless steel stampings used in aircraft exhaust systems and one of the first large projects in which 310 stainless steel is employed.

In fabricating these components, it is necessary to heat treat the steel for annealing and stress-relieving purposes. But the standard nitric-hydrofluoric acid baths would not remove the tough furnace scale

(Continued on Page 22)

Field Representatives Assemble

Coming together from their far-flung posts, Ryan's U. S. field representatives met in conference recently at the San Diego plant. Scheduled by Sam C. Breder, Director of Customer Service, this conference provided Ryan representatives with the latest information concerning new products, manufacturing developments and technical services which Ryan makes available to its customers.

Attending the meetings were (left to right): C. L. Foushee, Jr., Service Manager; Rod McDonough, Eastern representative with headquarters in New York City; James Stalnaker, Northwest area representative stationed in Seattle, Washington; Jack Zippwald, Assistant Director of Customer Service; Sam C. Breder, Director of Customer Service; Edward Meripol, Southern California representative, stationed in Los Angeles, and Richard Offenberg, Central Area representative with headquarters in Dayton, Ohio.

Primary purpose of the conferences is to keep Ryan's trained staff of field specialists up to date on the latest factory developments so they can better serve the clients whom they contact in their respective regions.

ATOMS IN HARNESS

(Continued from Page 21)

which formed on the 310 stainless steel. No commercial product was available which would do the trick. The problem was given to the chemical laboratory.

They found that the tenacity of the 310 scale was due to its high chromium content. 310 stainless contains between 24 and 26 percent chromium, which is higher than any other steel of its group. As a result, when it is heat treated it forms a high chromium content scale which is not acid-digestible in standard pickling baths. With this starting base, the staff experimented until RACO 701 was developed.

RACO 701 is a solution into which the 310 parts are immersed prior to heat treatment. The bath is operated at a temperature of 180°F. As the parts are removed they flash dry in air, leaving a coating of RACO 701 on their surfaces.

When the metal is heat treated the compound adhering to the surface converts the low oxides of chromium in the scale, formerly obtained, to water-soluble chromium trioxide which can be washed away. With the chromium in soluble form, the only additional task is the removal of the iron and nickel oxides. These are readily removed in the standard nitric-hydrofluoric acid bath.

Ryan has processed thousands of Pratt and Whitney parts through this system and it has proved eminently successful for two years. The RACO solution does not break down and the only loss experienced is the slight amount caused by its drag-out on the parts. The bath works equally well with all types of stainless steel and its use greatly speeds up the action of the standard pickling bath.

Without this new technique, a number of the 310 components could not have been built because they have designs which preclude heat treating with molten salt bath methods—the only other alternative. Their configuration would have caused the entrapment of corrosive salt.

INCONEL DRY LUBRICANT

Lubricants are employed with most forming operations at Ryan but seldom was one so urgently needed as when Ryan began to build transition liners for General Electric jet engines. Made of extra-tough Inconel, transition liners are rather complex-shaped ducts which channel flaming gases in jet power plants. These incorporated several severe formings. Using 50-ton presses and ordinary oil and grease type lubricants, a goodly number of wrinkles formed in the parts because the holding dies allowed too much of the excess metal to flow into the forming die. These wrinkles had to be hand worked out. This was unsatisfactory. It was expensive but, most important, it produced scratches and other blemishes on the surface of the parts. Because these parts are subject to extreme temperature and vibration in service, such imperfections were not acceptable.

The problem was accentuated by the fact that, at the time, Ryan did not have additional presses available, of greater capacity, to devote to the work. The chemical laboratory was consulted to see what could be done. Bernard Floersch and his staff made an analysis of the problem. They determined that the 50-ton presses could be utilized to form smooth parts if a lubricant of "controlled drag", or slippage, could be devised. Obviously, the oil-type lubricants were allowing the excess metal to flow too readily under the 50-ton pressures used. On the other hand, a certain amount of flow was necessary in order to keep the metal from thinning.

From their work, the chemical laboratory devised RACO 300—a dry lubricant with the prescribed properties for this job. Using the new compound, the Inconel transition liners can be formed at 35-ton pressures without wrinkling. This eliminates hand work and avoids marring the parts' surfaces. RACO 300 acts as a "barrier" coat which keeps the metal surfaces separated in the forming operation, to prevent galling, yet allows a controlled slippage to avoid thinning.

RACO 300 also provides added benefits which were not at first anticipated. It acts as an anti-scale compound and prevents sensitization in the subsequent heat treating of the transition liners. Inconel is susceptible to sensitization from the fluctuating oxidizing and reducing atmospheres prevalent in annealing furnaces. This sensitization renders it subject to attack from the nitric-hydrofluoric acids used to remove the furnace scale. The acids attack the Inconel parts and destroy the surface finish so that they are not suitable for precision applications.

If the RACO 300 drylube is left on the parts, after forming, it protects them against sensitization in the furnaces and reduces the amounts of scale formed. A welcome saving is also realized because degreasing of the parts is thereby eliminated by this procedure.

These examples are illustrations of only a few of the more than 50 RACO compounds in current use at Ryan. However, they are typical of the problems which the chemical laboratory must meet and they serve to point up the effective way in which this facility aids production in an undramatic but vital way.

LITTLE INCH FOR ARGON

(Continued from Page 10)

of argon cylinders, which Ryan used throughout three large buildings at the rate of 572 bottles a month, groups of them had to be stored in designated locations within the plan. This presented a safety hazard because the cylinders were charged to a gas pressure of 2200 p.s.i. and had to be handled with caution.

Undoubtedly, the major financial benefits which will accrue from the adoption of the new facility will be the savings which bulk purchases will provide. Instead of buying the gas in 275 cubic feet bottles, the entire system can be charged with thousands of cubic feet in a single operation.

By reading the pressure and temperature gauges on the banks and consulting a chart, it is a simple matter to determine the exact volume of gas in the system. When a bank drops to a predetermined volume the supplier is called and a tank truck delivers the gas to Ryan and pumps it into the low bank. While one bank is being replenished, another is used to feed the plant. The third bank is employed as a standby supply. In this way all previous production interruptions caused by local gas shortages and shut-downs are avoided.

The pressure of the argon is regulated to 25 p.s.i. as it leaves the storage system and no further regulation is required at Ryan's 85 inert gas-shielded welding stations.

The welding booths are equipped with Ryan-designed gas and water flow timers. These devices automatically control the flows of argon and cooling water during the welding process. Their action is designed to provide a timed gas flow after welding ceases to protect the hot electrode from oxidation.

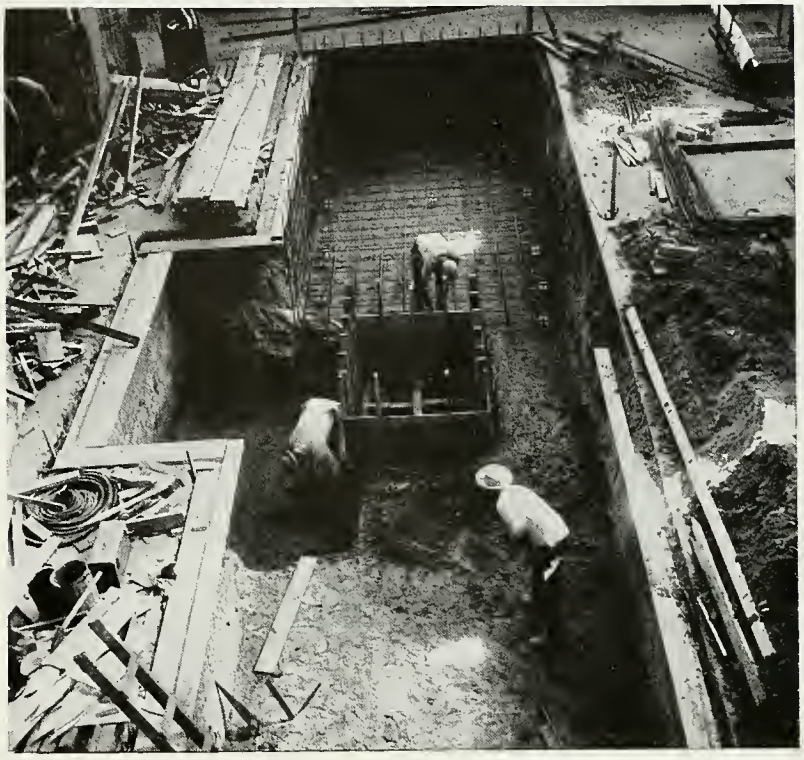
Because they save substantial amounts of gas, by eliminating guesswork, these timers pay for themselves in sixty days of use. Ryan plant engineers estimate that the new storage facility and the automatic timers will accomplish a saving of more than $5,000 a month in Ryan's argon gas costs.

Argon gas is used for most of the shielded arc welding at Ryan because it is best suited, physically and economically, for these tasks. Obtained through the fractional distillation of liquified air, commercial argon is 99.9 percent pure. That is far above the purity standards of commercial helium, also used for shielding purposes. Argon is heavier than helium and, consequently, only two thirds as much is required to duplicate a weld made with helium. However, in some cases Ryan uses helium gas for automatic welding of aluminum because it lends itself to the higher welding temperatures and faster speeds of this method.

Argon was discovered in 1894. The name means "lazy" which appropriately describes its inertness. Like helium, neon, krypton and xenon, argon is one of the inert gases which are present in minute quantities in air. The other member of this family of gases is radon, produced by the disintegration of radium and not found in the atmosphere.

No compounds of these gases have ever been made, with the possible exception of krypton, because of their chemical inactivity. This inertness is explained on the basis of their atomic structure. In every case their outer electronic group contains eight electrons—a number regarded as the most stable arrangement possible. As a result, atoms of these gases do not lose, gain or share their electrons and their structures represent the stability which other atoms attempt to gain in their inter-reactions.

For these reasons, these gases can provide excellent shielding from oxidation without themselves being affected by the heat of the welding arc or the chemical affinity of the hot metal. They do not dissociate in the arc, as hydrogen does, so that the heat characteristics of atomic hydrogen are not present.



BIG PIT

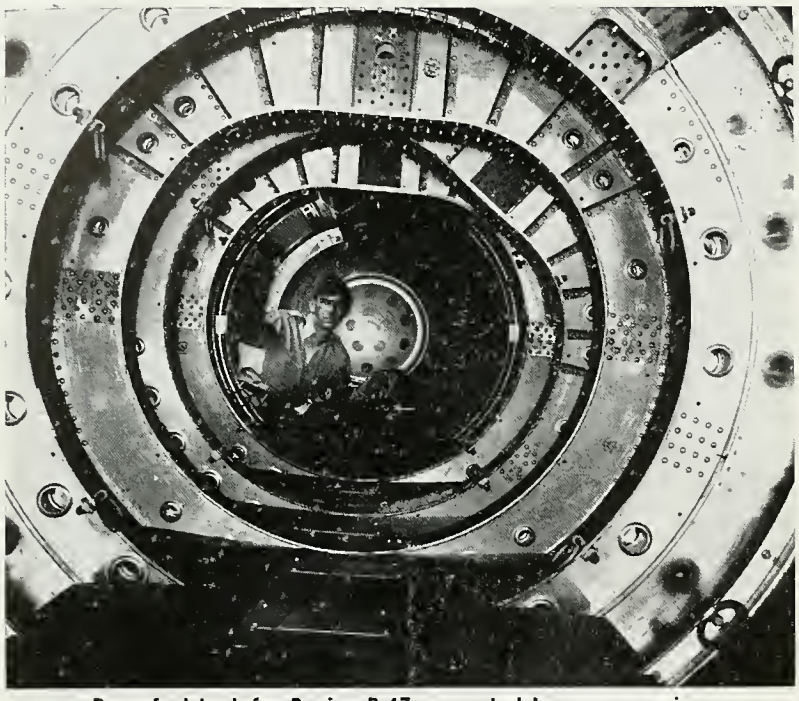
Three major excavations have either been completed or are nearing completion in various factory areas.

They were dug to provide foundations for the 300-ton expanding mandrel in the jet building, the stress relieving gas-fired furnace in the jet building, and the huge new Sheridan stretch press due for delivery soon in the main factory building.

The stretch press, which weighs 45 tons, will have a 90-ton stretch capacity. It will be used for stretching aluminum sheets used in the Boeing contracts. Most of the working parts of this press will be below the surface, with only the moving tables above the floor.

The pit to accommodate these working parts is 50 feet long at its maximum length, 14 feet wide, and with a maximum depth of 11 feet, 9 inches. The giant press will be installed alongside a smaller Sheridan stretch press, with a ten-ton stretch capacity, the first of its kind in the plant. The smaller press, now in operation, was installed last spring.

Installation of the two presses will enable Ryan to perform virtually all the metal stretch operations which had been farmed out to subcontractors as far away as Dallas, Tex.



Ryan fuel tank for Boeing B-47 converted to cargo carrier.

TANKS FOR TANKERS

(Continued from Page 4)

Stratofreighter series, and it can carry cargo items without removal of refueling equipment, made possible through relocation of aerial refueling tanks.

New, improved Pratt & Whitney Wasp Major engines, the R-4360-59's — the "Dash 59"— first installed on the KC-97F, also are used on the new model. As a tanker, the plane uses the Boeing-developed Flying Boom, a telescoping, controllable metal pipe through which fuel is rapidly transferred to receiver planes in a system that has been standardized by the Air Force.

It is the standard refueling tanker for B-47 wings, but also has refueled other planes. For instance, last year, when the F-84G Thunderjets of the 31st Fighter Escort Wing of SAC, staged its unprecedented mass movement from Georgia to the Far East, they were refueled over the Pacific from earlier Boeing KB-29P Flying Boom tankers.

Stratofreighters are in world-wide service with Military Air Transport Service, carrying troops, supplies and hospital patients. For the SAC, these planes are used in cargo missions to support bomber and fighter movements, as well as aerial refueling.

CROSSING NEW FRONTIERS

(Continued from Page 6)

electronics section. Increases in activity also have been shown in the sections working on jet and rocket components, exhaust manifolds and airframe components.

Flight test operations under jurisdiction of the engineering department are varied. Numerous remote-controlled flights are being made at Holloman Air Development Center, Alamogordo, N.M., of the jet-propelled "Firebee" target plane. Ryan pilots are testing Ryan-built electronics equipment in a Lockheed P2V Neptune Navy Bomber and a North American F-86 Sabrejet Air Force fighter.

The expanded hiring program has been directed by Curtis L. Bates, assistant director of engineers, who last February joined Ryan after many years in top engineering posts at Northrop. Details of recruitment have been handled by William T. Immenschuh, executive engineer, and Joseph D. Chapman, administrative engineer, who has successfully sought qualified engineers in trips as distant from San Diego as Washington, D.C.

The increasing complexity of airplanes, guided missiles, and rockets has made the demand for engineers the greatest in aviation history. At Ryan, the present build-up is seen as only the beginning of still further expansion with acceptance by prospective customers of advanced developments conceived by engineers as they venture beyond previously uncrossed frontiers.

BOEING BOOM

(Continued from Page 13)

Renton plant would be intrigued with the sight of a unique horseshoe-type assembly line of KC-97s which fills the factory. This line doubles back on itself, permitting final assembly of the huge planes with the minimum movement of personal and parts.

Fuselage panels, wing structures and thousands of components flow into one end of the horseshoe and gradually grow into a complete Stratofreighter. As the partially completed airplane rounds the curve of the horseshoe, it gains wings, wheels and engines. Complex equipment is installed inside. Continuing down the final leg, the plane takes final form and rolls out of the mammoth doors.

Many of these parts are built in the Renton plant. Others are fabricated more than a thousand miles away. Ryan builds the huge aft fuselages, cargo doors, floor beams and exhaust systems which have formed an integral part of every Stratofreighter for the past four years. This year, Ryan has stepped up the rate of production of these units and of the refueling pods by a whopping 90 percent to keep step with Boeing's requirements. The increase was accomplished in only 13 percent more factory space through an efficient rearrangement of Ryan facilities and improved methods of fabrication.

Biggest Ryan-made components, the aft fuselages are 38 feet long and 11 feet in diameter. The refueling pods, which will contain the refueling-in-flight operator, fit into the huge loading bay on the underside of the aft fuselage. These pods are interchangeable with cargo doors depending upon the airplane's mission. Master tooling of ultra precision is used at Ryan to assure that the big assemblies will mate perfectly with center fuselage sections in the Boeing plant.

Ryan builds 49 aluminum alloy floor beams for each Stratofreighter. These remarkably light-weight structures are fabricated almost entirely by spotwelding. They support the Stratofreighter's floor which can sustain more than 60,000 pounds of cargo.

Each of the Stratofreighter's powerful Pratt and Whitney engines is equipped with a Ryan-built exhaust system of stainless steel. These complex structures collect the flaming exhaust gases from the aircraft's four 3500 horsepower engines and safely convey them to the atmosphere. In addition, the heat energy of the exhaust is harnessed by the Ryan system to power the plane's turbosuperchargers which give the engine's their high altitude performance.

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PILOT TRAINING

(Continued from Page 15)

educational background. They have to have ample experience in tactical fleet aviation in order to know and understand fleet operational problems. But above all else the nominee must have shown an intense interest in aviation and be eager for the opportunity to take an active part in the development of future naval aircraft. No rank requirements are specified. Whether he is a jaygee or a commander doesn't mean a thing—flying experience and having brains and knowing how to use them are the things that count most.

The school doesn't look like a school. No ivy covered brick walls steeped in tradition adorn it. It is housed in a two story white frame structure that looks like a junior size administration building and is located across the street from the school's flight line. The casual visitor would never notice it as they tour the 6800-acre tract of flat land at the mouth of the Patuxent River on Chesapeake Bay.

The school has a competent and experienced staff. Commander Joe Smith is the director. Joe is an old hand at this test business. He was one of the first to graduate from the school he now directs. He holds a B.S. in Mechanical Engineering from the University of Utah and he is also a graduate of the famous Empire Test Pilot's School (England).

Working with Joe are four other naval officers, one Marine officer and four civilian engineers. Other engineers will recognize the names of the latter—Daniel O. Donamasch, Walter J. Hesse, Robert A. Fuhrman and Paul R. Miller—from the books and many papers on technical aviation subjects they have written.

(Fuhrman, who holds an aeronautical engineering degree from the University of Michigan and a masters degree from the University of Maryland, recently joined the Ryan engineering staff. He was aerodynamics instructor at Patuxent.)

The course is sort of a two pronged affair including academic study in aerodynamics and related aeronautical engineering subjects and in practical test flying and data reduction.

In the morning the student attends classroom lectures where during the five and a half months he'll have the better part of 24 highly technical textbooks thrown at him. It is tougher for some students than for others. Pete Girard, who is a graduate mechanical engineer from the University of California and can spit out logarithms with the best of them, found it no strain, but some of the boys who kissed their calculus books goodbye before World War II find it a real grind. One of them told me he looked out a window one day and missed all of the polar coordinates. He was joking, of course, but it is true that the pace is fast and students cannot afford to dope off.

The first five weeks of lectures are devoted to sort of a warm-up, turn-over, and review of such snaps as trigonometry, fundamental engineering mathematics, calculus, physics and thermodynamics. Then, as the student hits his stride he gets materials and structures, aircraft power plants, aerodynamics, aerodynamics, aerodynamics and then some more aerodynamics until he can reel off variations of coefficients with Reynolds' Numbers as easily as most of us can say "five will get you ten."

In the afternoon the students take their laboratory work, which means flying and writing up the flight. With the exception of familiarization hops in new types of aircraft and in keeping up their instrument and night flying proficiency, all flying is syllabus test flying. That is head-in-the-cockpit, eye-on-the-gauges stuff, nearly all work and not too much fun. It means flying a lot of different types of aircraft—a wealth of flight experience in a short period. Girard says that he considers this opportunity to gain experience in so many different types of planes, (jet fighters, reciprocating fighters, attack, patrol boats, 2 and 4 engine land based—plus various trainers) as pretty much the highlight of his aviation training. This experience will prove invaluable in mapping future projects at Ryan.

Students fly about 25 hours a month. The test flying consists of approximately 50 percent group effort and 50 percent individual effort. The class is divided into groups of approximately five pilots each for the purpose of combining efforts in making a complete performance and stability and control evaluations of a designated aircraft. One instructor rides herd on each group of five. For his individual effort the pilot will cover the various phases of handling qualities testing, which includes qualitative lateral-directional stability, stalling characteristics, rates of roll of all the 11 different types of aircraft assigned to the school, maneuvering stability of several types of aircraft, investigations of high Mach characteristics of jet aircraft, determination of buffet boundaries of jet aircraft, and a one-flight evaluation of a jet aircraft.

After each flight comes the flight report, usually described as the (*!£@*!). Heavy emphasis is laid upon accurate, concise and complete reports because if you can't record and pass on what happens, all you've done is stuck something up in the blue and don't even have a hole to show for it. But the reports are real time-eaters. As Girard discovered, it takes five to six times as long to write up the report as it does to make the hop.

In addition to individual reports, each group submits a final report comparable to a regular flight test report of service acceptance trials.

Attending ground school, flying planes and making reports comprised a working day of 12 to 13 hours—6½ days a week—for Girard. It was the most intensive educational experience of his life.

What does it all add up to? Well, I asked Girard what he thought of the course, let him say it in his own words: "I think the school is very good—it combines the bookwork and the actual testing extremely well. The ground school subjects are very well selected and well presented. The flying covers so many types of airplanes with so many performance and stability and control investigations that the graduate of this school can certainly consider himself a well educated and experienced engineering test pilot. Unless one has experienced this type of training, he cannot even begin to appreciate the terrific education that we are getting."

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ON THE COVER

The Ryan Firebee, the Department of Defense's new pilotless jet target plane, is shown an instant after it is ground launched from a 60-foot rail with the aid of a rocket at Holloman Air Development Center, New Mexico.

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AFT FRAMES FOR GENERAL ELECTRIC JET ENGINES MOVING THROUGH RYAN'S JET BUILDING, LINDBERGH FIELD, SAN DIEGO, CALIFORNIA.

LEADERS
IN HIGH TEMPERATURE METALLURGY
FOR JET, PISTON AND ROCKET ENGINES

VOL. 14, NO. 6

THE AIRPOWER FUTURE

by James H. Smith, Jr., Assistant Secretary of the Navy for Air

An address before the Air Force Association Airpower Symposium

Technological advances give Naval aviation new dimensions

THE Navy's share in shaping the future of air power is a subject close to those of us on the Navy's civilian management team. In the Navy, the Assistant Secretary for Air is also assigned responsibility for the Navy's research and development program. Put these things together—my own personal interest in aviation, my abiding faith in the Navy's sea-air team, and my constant concern with problems of research and development—put these together and you will understand why I am happy to discuss the future of Air Power.

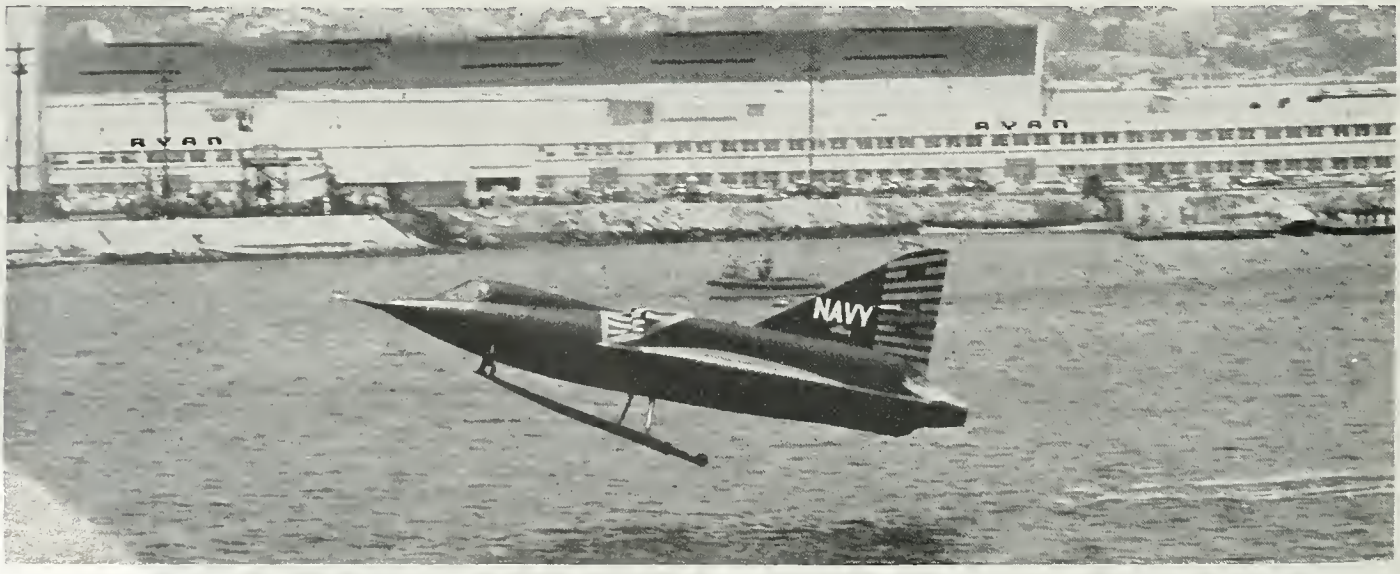
Rather than recount the Navy's assigned missions in detail, I have selected one—naval striking power—and will show how the technological revolution of the past few years has given it new dimensions. One thing we hold essential is that command of the sea is possible only where we control the air above the sea.

I would be remiss if I did not also point out our advances in our other very important tasks of air defense and anti-submarine warfare. But first let us examine those technological advances in aero dynamics and propulsion and electronics which have broadened the horizons of naval striking power. In these fields each push forward has opened up new problems—challenging problems which must be solved.

The chart on Page 2 will help you visualize the changes wrought in naval aircraft in the past few years—and the performance increments—maximum speed, rate of climb, service ceiling, maneuverability and ordnance capacity.

As aircraft characteristics have changed, improved plane-handling capabilities have been made necessary in our aircraft carriers. As every aircraft weapons system has advanced, its base has been required to expand in facilities. Similarly, the aircraft carrier has undergone the necessary increases in catapult capacity, arresting gear capacity, and servicing facilities—such as ordnance and fuel storage. The chart opposite shows how we are getting

Convair's new delta-wing Navy jet fighter, the Sea Dart, takes off from San Diego Harbor in front of Ryan plant for test flight.



these increases without an inordinate increase in carrier size.

We have found that if we are able to keep airplane size and weight at manageable levels, better performance depends upon one necessary condition—higher minimum flight speed. This means improved landing and launching capabilities. Here the aircraft carrier has shown its ability to keep abreast of the rapid progress in aircraft performance. Not only has it kept abreast; the carrier's improved airplane-handling characteristics have even extended the horizons of naval aircraft development.

Let me be specific in the landing and launching field:

Our new British-developed steam catapult has the power to launch the heaviest attack bomber which we now have under development, and contains a margin for growth. The energy of the steam catapult is greater by a factor of ten than that of the catapults on the World War II ESSEX carriers.

Our newly-developed arresting gear will allow us to land the heavier, faster planes of the future. The energy absorption of this gear is greater by a factor of nine than that of World War II equipment. The problems of launching and landing have always received basic consideration in the design of naval aircraft.

But these two Navy developments—the catapult and arresting gear—are not of use to the Navy alone. We are pleased that with the high flight speed spectrum of land-based planes, the Air Force is looking with interest upon catapults and

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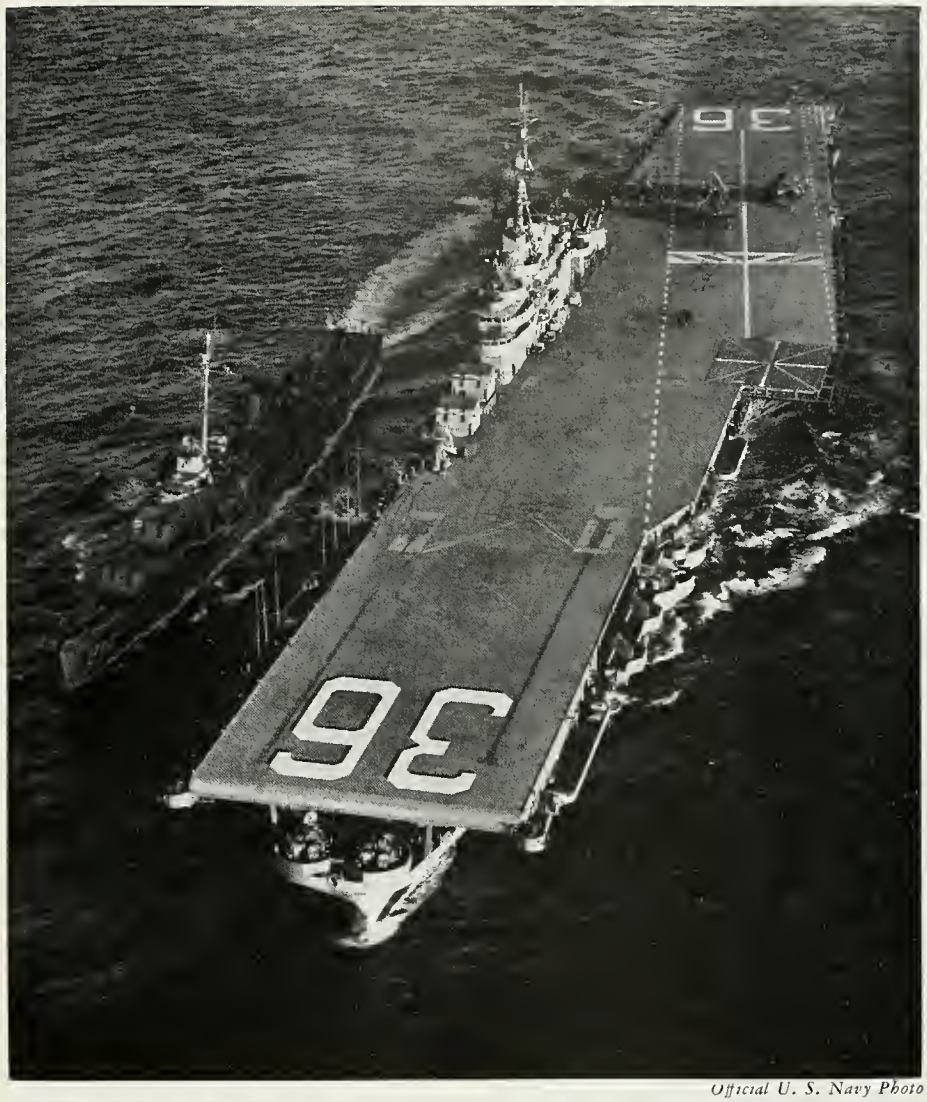
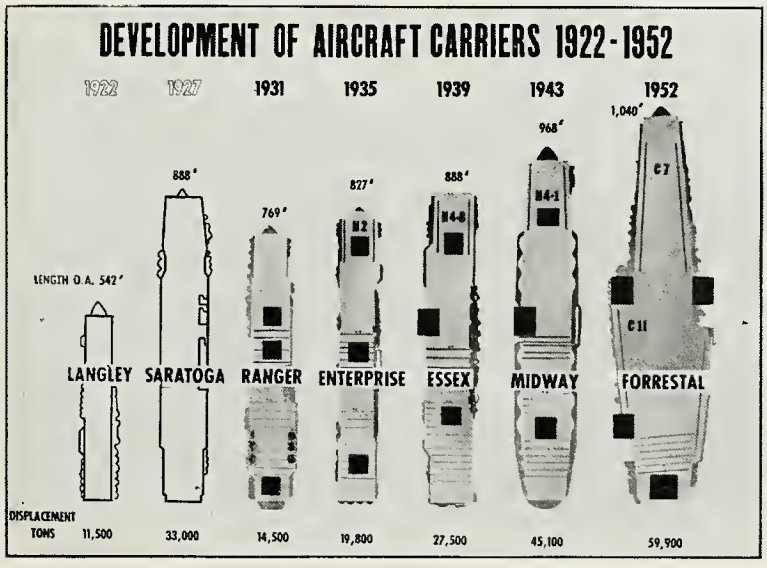


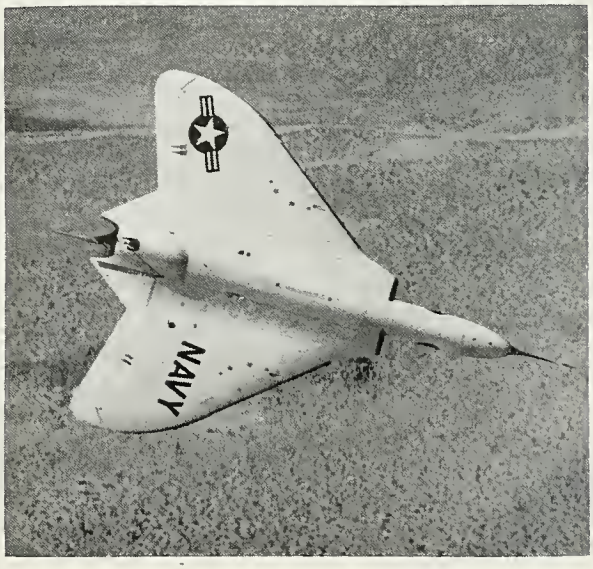
Official U. S. Navy Photo

Aircraft carrier Antietam is shown refueling one of its escorting destroyers, U.S.S. Corry, at sea in the Virginia Capes area during maneuvers evaluating new canted deck.

Despite tremendous increases in planes' speed and power, and need for greater servicing facilities, carriers have not grown inordinately.



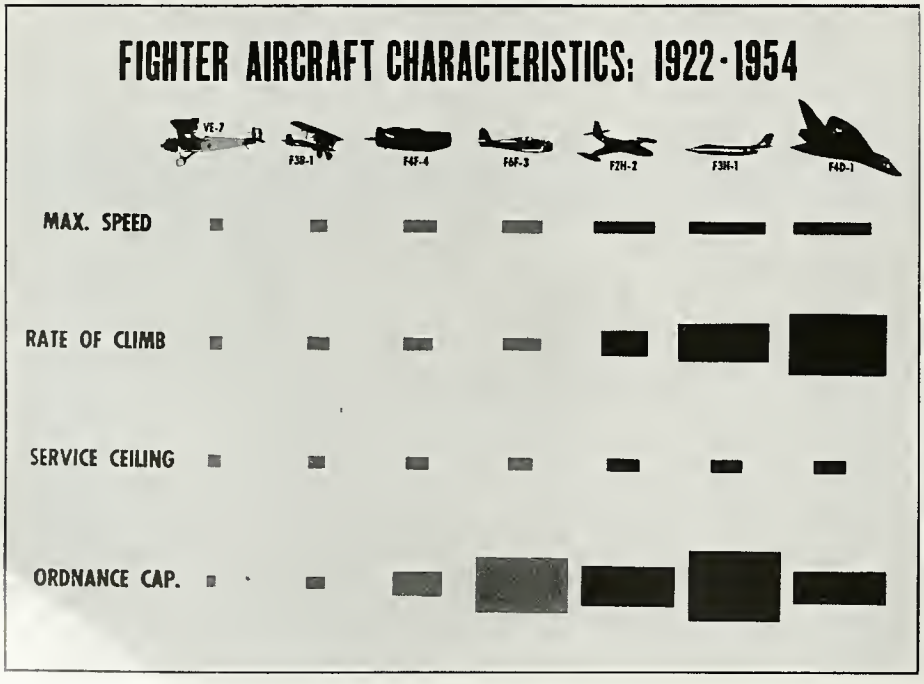
World's speed record for regulation course, 753 mph, was set recently by Navy Douglas Skyray interceptor.



Official U. S. Navy Photo

Hunter-killer teams of surface ships, airplanes and blimps seek out and destray enemy submarines. Snorkel breathing devices and streamlining make sub more elusive target.

Performance characteristics of Navy carrier-borne fighter planes have changed remarkably, including speed, rate of climb, service ceiling, maneuverability and firepower.



arresting gear for take-off and landing operations ashore.

Finally, the two-runway system aboard a carrier—the canted deck—has greatly increased the carrier's flexibility. Now simultaneous take-offs and landings can be handled with less interference. Further, carrier operations are safer. In flight operations during the past few months aboard the canted deck carrier ANTIETAM, more than 5000 landings have been made during daylight, darkness, and low visibility without a single barrier accident.

The pressure upon the enemy which a carrier airgroup can deliver depends directly upon the cyclic rate of launching and recovery of its aircraft and the speed of the aircraft to and from the target. After delivering its offensive load to the target, each plane returns to the carrier, lands, rearms, refuels, and launches. With the canted deck and improved servicing features, the time required on board will be greatly reduced.

This is the way in which steam catapults, superior arresting gear, and canted decks affect airplane progress. Our carriers can handle the increased minimum speeds which we have accepted to reach our goal of increased performance. This means that supersonic fighter and attack planes can and will be operated from aircraft carriers. The FORRESTAL class carrier embodies all these improvements and has a margin for growth in facilities to accommodate future airplanes.

While engrossed in the problems of improving our aircraft carriers we have not been blind to the possibilities of other means of launching and landing aircraft. Indeed, nothing so corrodes our creative machinery as putting blinders on imagination.

Examples of past successes are JATO and the new seaplane hull design. In the immediate future there are hydroskis, vertical risers and convertiplanes.

From our extensive development of hydroskis there has resulted an airplane of maximum versatility. This is the experimental SEA DART. Here the aerodynamicists and hydrodynamicists found themselves teammates whose efforts directly contributed to solving each other's problems. For instance, the aerodynamicists were delighted with the high landing speeds and naturally existing water runway which became available from the hydrodynamicist's development of hydroskis. Here is a plane which has the ability to land on various surfaces and to base aboard a carrier, a tender, or ashore. Such operational versatility in a single plane is invaluable.

Let us look at some of the new devices which the future may bring.

To secure effective aircraft weapons systems, seven-league strides in propulsion have taken place. No matter how sophisticated our aerodynamics may become, to make an airplane move fast through the air demands a mighty push. So much thrust is now being wrapped up in so light a package, that—as we approach flight speeds of Mach 2 with turbojet aircraft—we have the thrust necessary for vertical take-off and landing. When stability and control problems are solved, the operational advantages which can accrue from vertical take-off and landing are obvious.

It is natural—in the research and development business—to think not of the advances of the past, but of the problems confronting us in the future. An example is the temperature barrier to aircraft speed which we now foresee. In our assault upon it, we find ourselves dealing with a "space and time" problem.

In World War II, 450 miles per hour was a respectable speed for fighter aircraft. Today, talk of tripling that speed is commonplace. We know, for instance, that the Douglas Skyrocket has flown at 1239 miles per hour. Simple arithmetic shows us that when we fly at three times our old speed, we will cover a given distance in one third of the old time. This introduces the "space and time" problem.

We know that the human mind is the best mechanism for reasoning, but we must also admit that as a computer it is relatively slow—far slower than many mechanical computers on the market. Here is the *time* limitation imposed by our greatly accelerated speed through *space*. For instance, in combat a pilot is confronted with a situation; he must assess that situation; he must decide what to do; he must do it. But the *time* required for the pilot to reason, decide, and act has not changed. So he must start this mental process earlier in *space*,—many miles earlier. So many miles earlier, in fact, that he probably has not yet sighted his opponent. So, to utilize the speeds of which his plane is capable, he must be supplied with mechanisms to reduce space and increase time to the dimensions of 1944 or 1918.

Official U. S. Navy Photo

HU-1 helicopter hovers over U.S.S. Soledo after completing another spotting mission. Navy helicopters also won laurels in the Korean war for rescues and other performances.

It is here that our progress in electronics has been of the utmost significance. Improved radar has extended the pilot's vision far beyond nature's gift. By improved communications the pilot's response to intelligence or command has been extended. In modern air-to-air combat, ground radar "sees" the distant planes, both enemy and friend. Through electronic communications the controller directs his fighters to the interception. By radar the pilot "sees" his opponent

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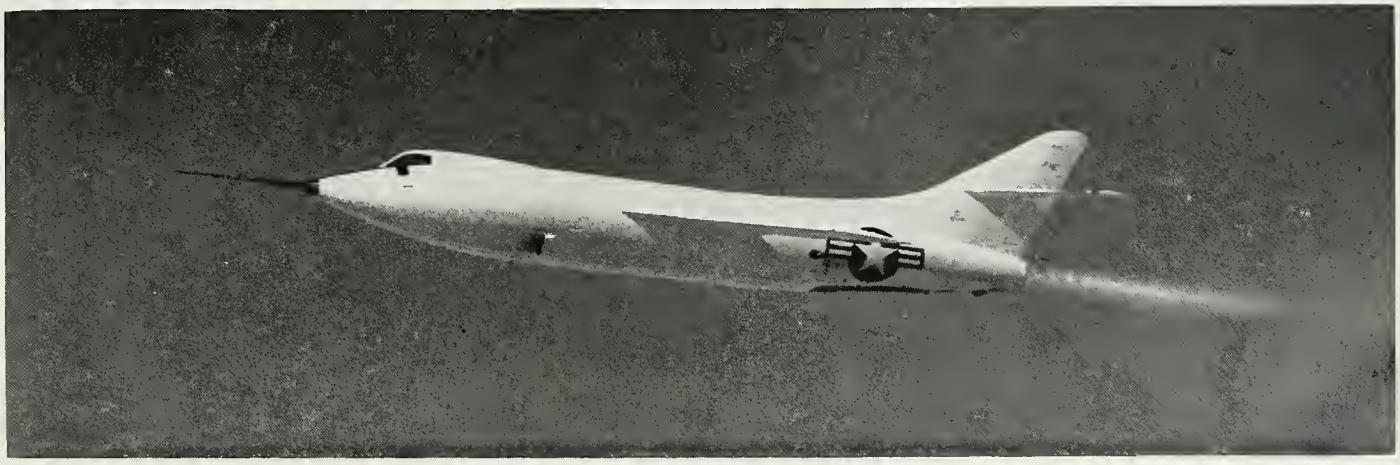
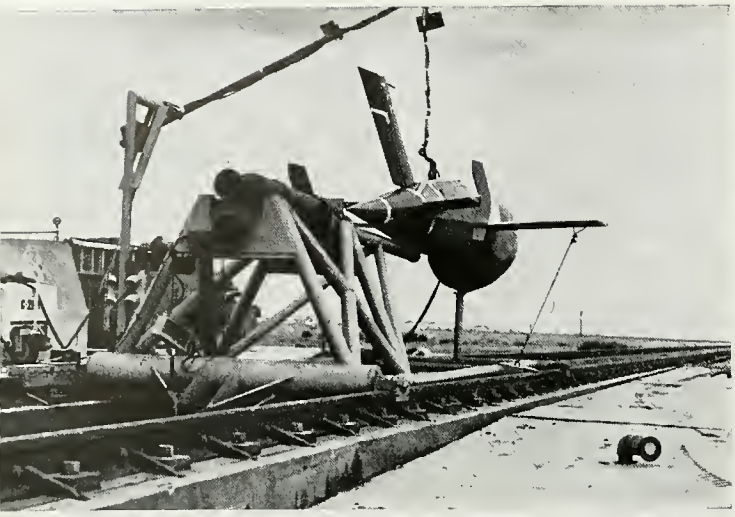
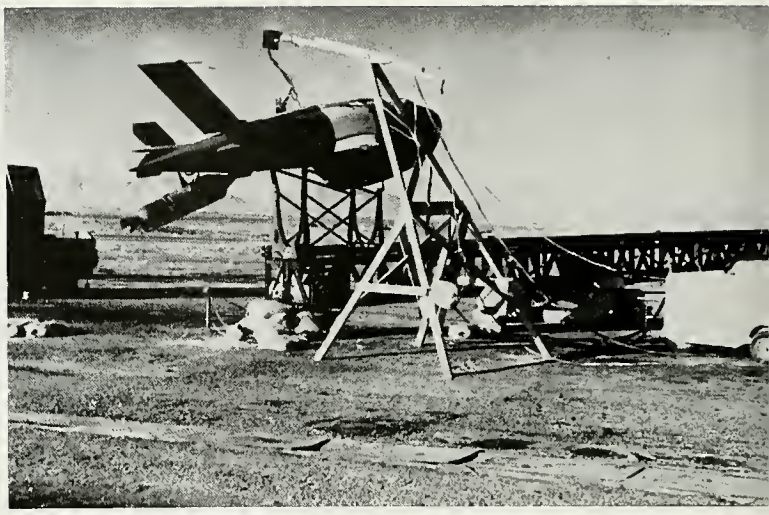
Flight speeds far in excess of sound have been achieved by such planes as Douglas Skyrocket, which has flown 1239 miles per hour.





Acceleration tests before actual launchings were made on this 4,000-foot set of rails, equipped to hold the "bird" captive.



This closeup on launching rails shows "umbilical" cords attached to carry control signals and start the engine before launching.

High-Speed Takeoff

WITH a jet-stream whoosh, Ryan's "bird" is taking off from the ground these days in a continuing test program at Holloman Air Development Center, N.M.

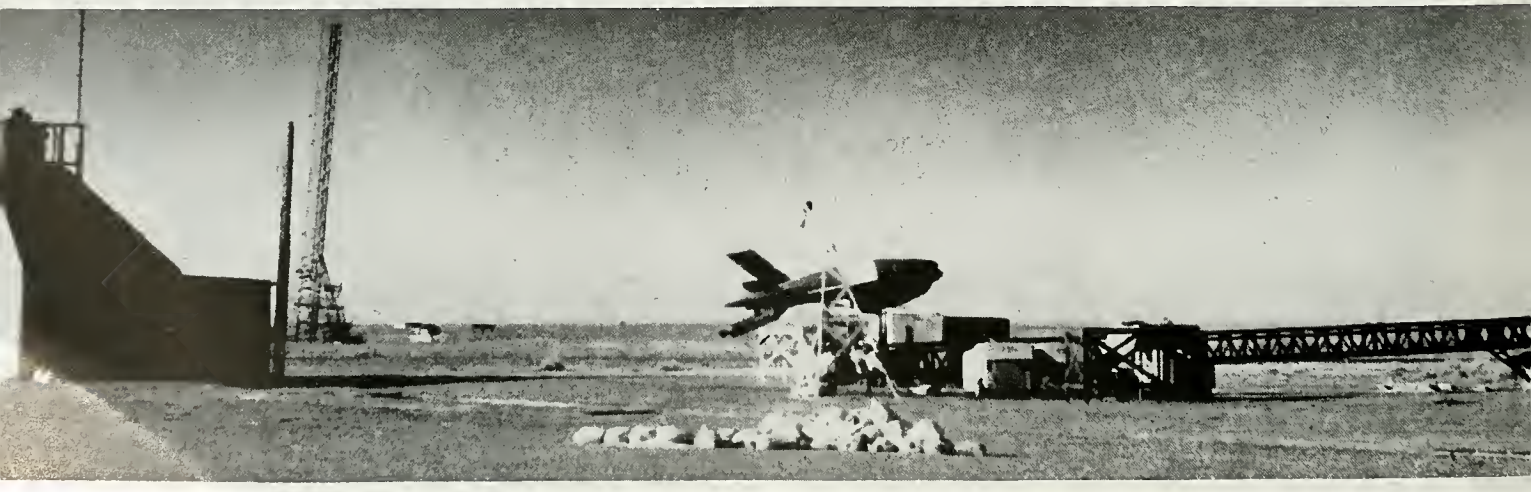
This is a variation in the hitherto customary conduct of the "bird". In the past, it has been dropped by a fast-moving launch plane, and then proceeded on its own, with electronic direction from a remote ground station.

The "bird" is the Ryan Firebee, the jet propelled, pilotless target plane that has been streaking across the New Mexico desert in an intensified test program for the past two years under joint sponsorship of the Air Force, Army and Navy.

All three of the services now either have in use or are awaiting delivery of these speedy planes that can simulate a combat aircraft for training in air-to-air or ground-to-air gunnery and guided missile exercises.

Each of the services has its own preferred method of launching. Army Ordnance, which has ordered an undisclosed quantity of XM21's, its version of the "Firebee", will utilize a ground launch system to get the "bird" into the air and within range of anti-aircraft and guided missile crews.

1. The Ryan "Firebee" is pictured in its cart on the 60-foot rail launcher at Holloman Air Development Center, Alamogordo, N. M., as it is prepared for ground launching. Army Ordnance, which has ordered these jet target-planes, will use ground launching.



The Ryan "Firebee", which has been dropped from launching planes, now is becoming accustomed to getting "shot" off the ground in test program

In test launchings conducted under the technical direction of the Air Research and Development Command, a 60-foot rail launcher has been employed. The "Firebee" is fixed to a cart made up of two castings and a welded tube assembly. Two "umbilical cords" — actually wire conductors or cables — are attached to the "bird" to provide the necessary external power and directional control signals.

One cord, a multiple wire cable, carries the control signals, while the other, consisting of two heavy wire conductors, channels the power for starting the jet engine. An "in-sight" operator controls the launching.

The engine is started a few minutes before launching, and is accelerated to full power before firing of the "jato" bottle, attached to the underside of the "Firebee". The "umbilical cords" are removed after completion of all electrical checks and just before the "jato" produces the sharp impulse for launching.

The rails guide the take-off, maintaining the vehicle at a fixed attitude. At the rails' end, a decelerating mechanism detaches the cart from the "Firebee". This consists of a snubbing device that shears the pins which hold the target to the cart. At this moment, the target is launched into free flight, carried for a short period by both the "jato" and the engine.

When the "jato" burns out, after about two seconds, it is ejected automatically and falls to the ground from an altitude of perhaps 50 to 60 feet. The "Firebee" is now dependent on its engine and the ground controls.

The "in-sight" operator is protected by sandbags from the tremendous shock-wave expelled by the "jato" bottle, which creates 10,000 pounds of thrust during its brief existence.

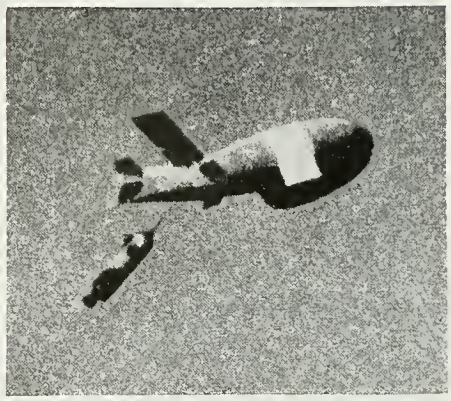
In a nearby solid concrete blockhouse, observers peer through thick, double glass windows.

More than a mile away from the launching site is the remote operator, to whom control of the "Firebee" in flight is transferred by the "in-sight" operator soon after launching. By land-line phone, the latter notifies the remote control operator to take over when the "bird" is at a safe altitude.

Before the first ground launching, tests were conducted on a 4,000-foot set of rails to determine the effects of acceleration on the target during and after launching.

On these rails, the target was held captive and did not leave the ground. Deceleration was accomplished by a scoop attached to the back end of the cart. The scoop acted as a brake through contact with water in a series of reservoirs beneath the rails. Several dams increasing in height brought the water to gradually higher levels during the run down the rails. The energy in throwing out the water from each succeeding reservoir was absorbed in decelerating the launching cart.

As ground launchings of the "Firebee" become more common at Holloman ADC, further refinements in the technique will be incorporated as the test program moves forward.



4. At a safe altitude, "jato" bottle is dropped by automatic ejection.

3. For brief period, plane is powered by both "jato" and the jet engine.

2. "Jato" bottle is used to produce 10,000 pounds of thrust in catapulting the "Firebee" into free flight. "Jato" provides energy for about two seconds.

AIR NAVIG

by Owen S. Olds, Chief o

Wanted by military aviation:

navigational system

Simulated flights are tracked on this Wright ADC globe by Marcus Gunning. Scale is 10,000,000 to 1.

IN SPITE of the amazing advances nurtured by electronics, the ideal system of aircraft navigation for military use has not been produced. Or, if it has, it is still wrapped in a cloak of secrecy.

This is a system which would meet the stringent requirements of long range flight under combat conditions. In a recent speech, General Curtis LeMay pin pointed these requirements when he said, "The mission of the Strategic Air Command is to be prepared to conduct offensive air operations on a global basis."

Basically, this implies that the military pilot must be equipped with a navigational system which will enable him to fly to any point on the face of the globe under all conditions of war and weather. It is evident that this eliminates those methods which depend upon ground facilities, visual references outside of the aircraft and radio communications because they cannot be completely relied upon under these conditions.

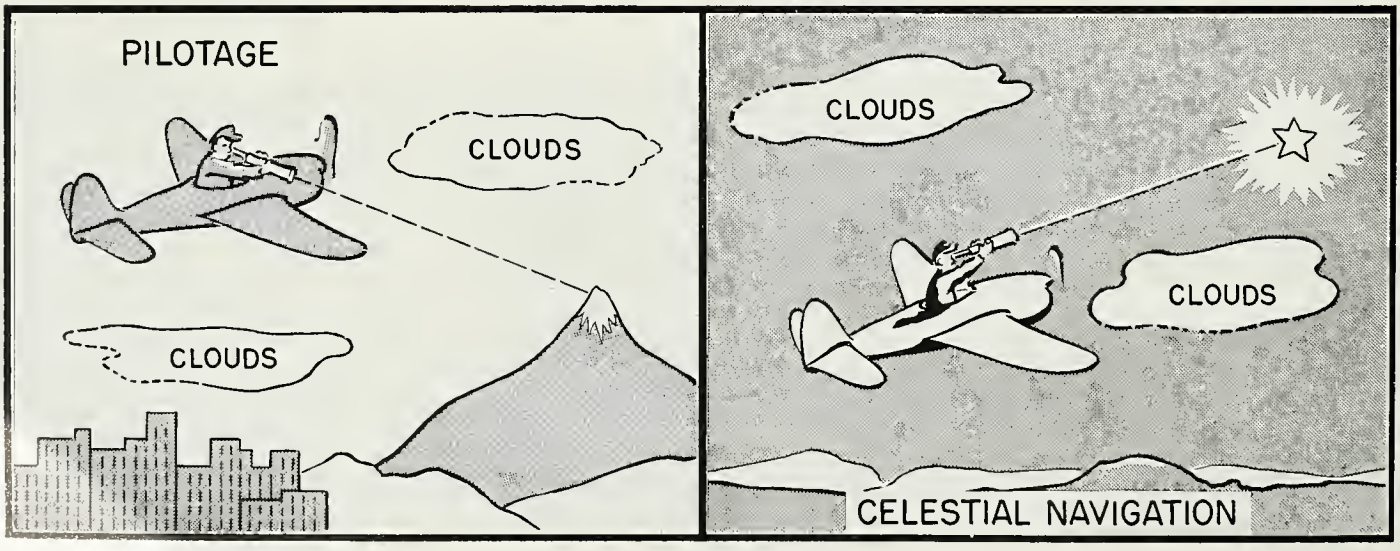
Over most of the world's surface, navigational aids from ground facilities are not available and none would be provided from facilities in enemy territory. Visual references cannot be used in bad weather, which may be the best weather, tactically. Radio communication must be ruled out in wartime because of its susceptibility to detection and countermeasure.

Logically, this narrows the choice of navigational systems to the self-contained, airborne type. In addition, the system must be fast and accurate. Preferably, it should be automatic and continuous, giving the pilot a simple, visual interpretation of all the complex data which must be coordinated.

With the advent of radio, radar and

First system used by early aeronauts was "pilotage" in which ground reference points guided the pilot to his destination.

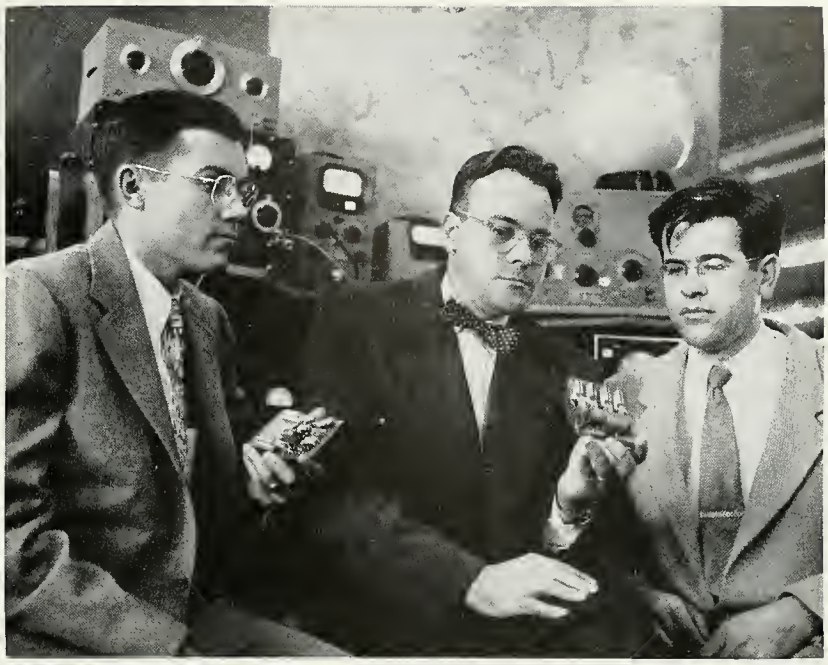
Borrowed from maritime use, celestial navigation was adapted to air needs to provide method for getting "fixes" enroute.



ATION

an Electronics Section

ompletely self-contained
eet global needs



Owen Olds, chief, Ryan electronics section (center), John Bowden (left) and Carl Gottwald (right) confer concerning miniaturized electronics systems.

electronic achievements, a bewildering parade of navigational gadgets and systems has sprung into being. Eminently successful in bringing commercial flights to their destinations, these methods fall short of global military needs. Perhaps a brief resume of the chronological development of airborne navigational aids will clarify the picture.

Since the days of Leonardo Da Vinci, men have dreamed of becoming airborne. But few envisaged that one of the first problems facing the aeronaut would be to find out where he was going. Unlike surface travelers, who could pretty well control their movements, early aviators found that they were floating in a multi-directional fluid which often took them miles out of their way.

Consequently, they navigated by constantly referring to ground reference points along the way. Called "pilotage" or "contact flight," this is still a good means for getting about under fair weather, daytime conditions. But, its effectiveness decreases at night and over water and it is useless when the weather closes in. Even in good weather, it requires constant comparison between maps and terrain and lends itself to confusion when flying over strange country.

As the airplane became a more reliable vehicle, a second system of navigation was adopted. Patterned after centuries of maritime use, this method is a self-contained system called "dead reckoning." Here, the pilot lays out his course on a map, computes his aircraft heading and estimates his anticipated progress. Once in the air, he navigates by compass and clock. In still air with perfect instruments, this would be a sure-fire system. But the air is usually not still and instruments are imperfect. Using dead reckoning, the pilot may be blown great distances off his course without realizing it. His projected flight is based upon anticipated winds which may be at wide variance with those actually experienced. Therefore, the system is faulty and the flight path error increases as the range of flight is extended.

To reduce the shortcomings of dead reckoning, another naval technique was borrowed. Celestial navigation was harnessed to aviation's use. Early airborne sextants were fashioned after the seagoing instrument. But celestial navigation

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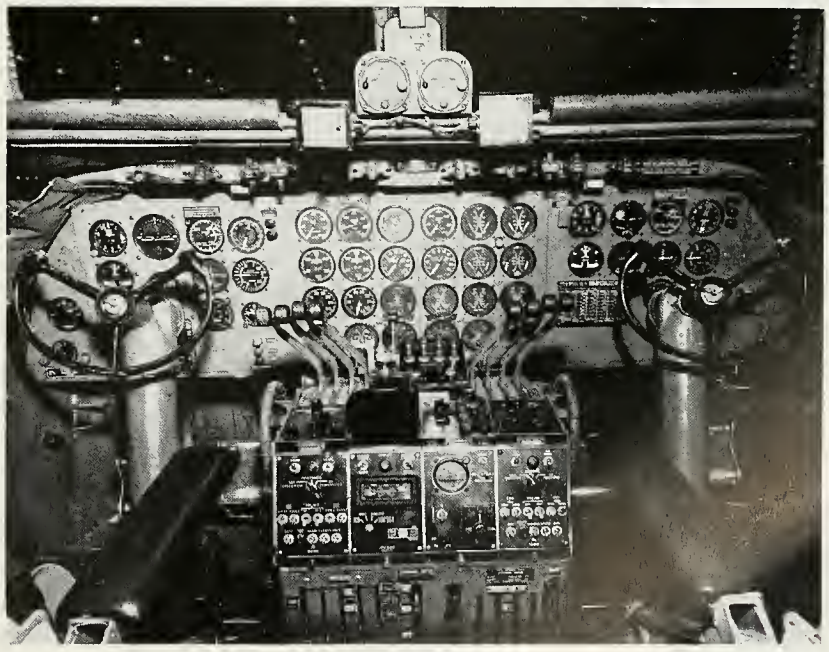
Typical array of modern navigational aids are these shown in a United Air Lines' DC-6. Included are ADFs, ILS, VOR, radar, gyros, radios and compass.



does not lend itself to the air as it does to the sea. It involves taking an accurate sight upon the sun, a star or other heavenly body.

Then, a series of time-consuming mathematical calculations must be made, utilizing the sight data as well as information obtained from tables. If sight and computations are accurate, a reasonably close determination of the observer's position may be made. However, since it takes about ten minutes to complete this procedure, the position found is not the present one but that occupied in the past. At speeds of 600 miles per hour, an airplane will have traveled 100 miles in the time required to determine a position. In the future, with speeds of 1000 miles per hour, this distance would be 166 miles.

Celestial navigation depends upon clear weather. It requires a stable observation platform and good facility for viewing the heavens. These requirements cannot be guaranteed for global military missions.

Up to this point, it can be observed that air navigation was a trial and error affair. Pilots flew with navigational systems which permitted substantial errors in course to occur. They relied upon some additional method for determining this error and correcting their track. Celestial navigation is that sort of aid.

Actually, it is more a system of detection than navigation because it gives the pilot a means for finding out where he is, or was, at any moment. So he flies from one known fix to another but may meander a good deal in between. His method of navigation is only as good as his method for getting fixes and this may fail completely when adverse weather occurs.

With the development of radio transmission, airborne navigation began to take on a different complexion. Now, fixes could be obtained at speeds commensurate with the increasing velocities of air travel. And, new techniques were uncovered which began to approach the continuous form of informational flow which appears to be the ultimate. Speeding at 186,000 miles a second, radio waves are an instantaneous messenger.

Probably the first elaborate navigational system growing out of radio transmission was the 4-course radio range. This method involves extensive ground facilities in the form of a transmitter and five high antenna towers. These are established at key airports and emit four radio beams along the airways to guide commercial flights. Beam transmission is on low and medium frequencies, between 200 and 400 kc. By listening to an "on course" signal, a pilot can fly along a beam to the station. Fan markers and cones of silence are auditory signals which indicate when the aircraft approaches and is actually over the station.

Although 4-course radio ranges serve an extremely useful purpose, they have several inherent weaknesses. They provide guidance only to those locations which are equipped with extensive ground facilities. Only four courses are provided to each station and off-course guidance is ambiguous. At low and medium frequencies, radio reception is susceptible to static and can become completely unreliable during electrical storms when it is most needed. At best, 4-course radio range permits an uncertainty in position which requires a complicated and time-consuming flight pattern to check.

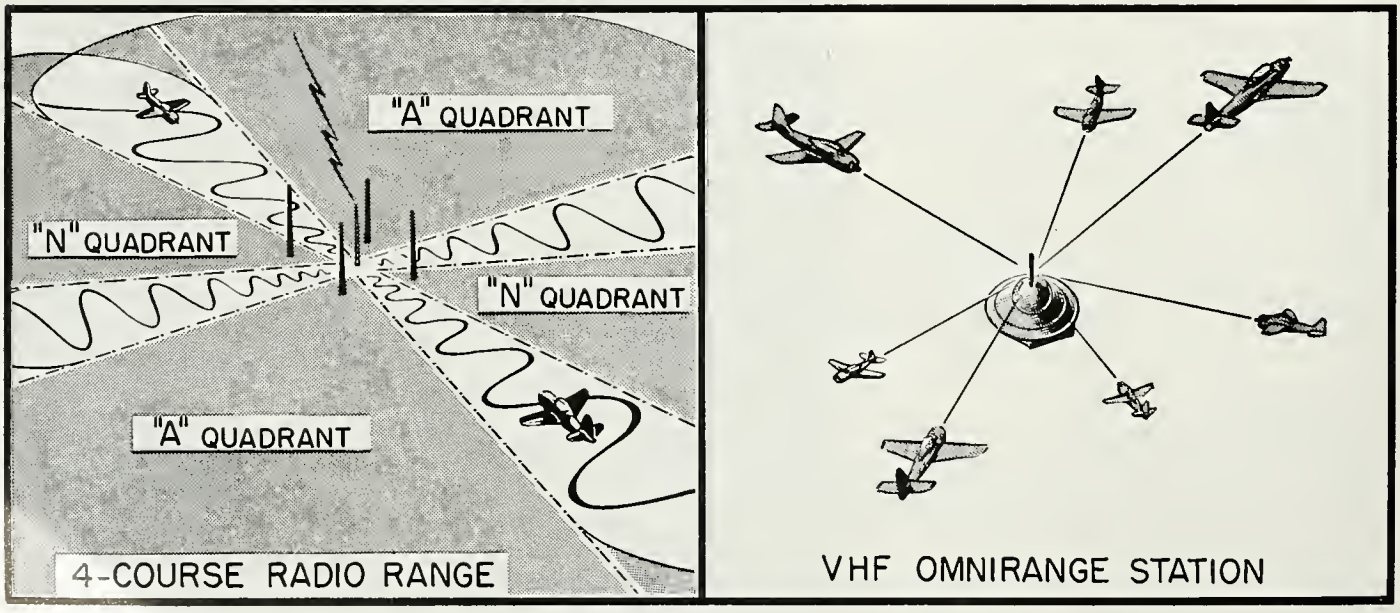
To overcome these objections, the present system of VHF Omnirange has been adopted. This equipment projects an infinite number of radial ranges in all directions so that an aircraft can be guided to the station from any direction. The ground facility is simple, involving a single antenna structure. Transmission has been switched to static-free VHF frequencies, in the 108 to 118 mc. band, which are dependable under all atmospheric conditions. Also, a greater number of channels are available at these higher frequencies.

VHF transmission is similar to that used in television in that the transmission is straight-line and does not follow the earth's curvature. The distance at which the signal can be received depends upon the altitude of the aircraft. Good reception can be expected to altitudes up to at least 40,000 feet.

With the VHF Omnirange (VOR) stations, a companion facility is being installed which fills a long-felt need. This is Distance Measuring Equipment (DME). Motorists jogging along the highways in their $2000 automobiles have an advantage which pilots of half-million dollar aircraft are denied. With their accurate speedometers, they know how fast they are going and how far they have traveled. The airborne pilot has had to depend upon his airspeed indicator which tells him only how fast he is going

4-course radio range brings aircraft to destination along "beams" which fan out from station. System is not reliable in bad weather and inadequate for handling heavy traffic.

With VHF Omnirange, an infinite number of radial ranges are projected in all directions. Transmission is dependable and facilities can serve all other destinations within range.

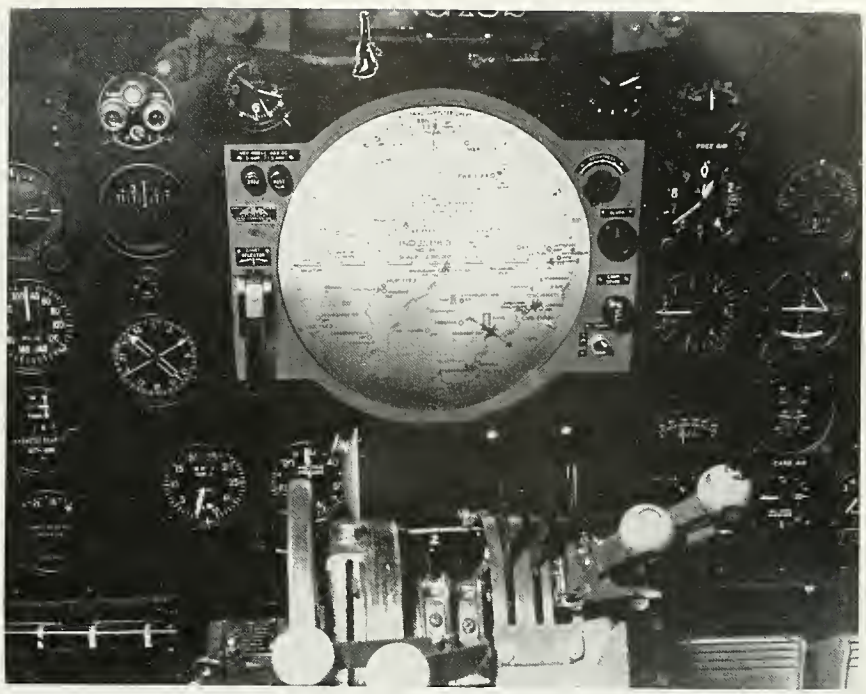


with relation to the air around him. While helpful, this instrument does not give him the necessary data concerning his ground speed or distance traveled.

DME is an electronic speedometer which gives the pilot his speed with relation to the ground and his distance to or from a point on the ground—usually a VOR station. It employs a receiver-transmitter combination in the aircraft which operates at about 1000 mc. in the ultra high radio-frequency band. The airborne equipment, called the "Interrogator," sends out a pair of radio pulses which are received by the ground facility, called the "Transponder." the Transponder replies with another pair of pulses which are received and analyzed in the aircraft. The elapsed time betwen transmission and reception of the pulses is electronically computed and translated into both miles and miles-per-hour and presented to the pilot by a direct-reading instrument.

Although there are a limited number of VOR/DME stations their usefulness is greatly extended by an ingenious device. Called a "Course Line Computer," this instrument makes it possible to fly to any destination within reception range of a VOR/DME station. The pilot simply sets certain navigational data into the computer. By electronic means, the computer analyzes the information received from the VOR/DME station and translates it into data which guides the pilot to the desired destination, just as if the VOR/DME facilities were magically transported to this point.

Recently a number of computers have been developed which pictorially present VOR/DME information to the pilot. These usually show a small airplane, which represents the navigating aircraft, projected on the surface of a map or chart. Progress is simulated by the automatic movement of the replica aircraft over the map. The pilot may simply watch this movement to determine his progress along the desired course. To date, these systems have tended to be bulky.



With Arma Pictorial Computer, shown installed in a DC-3 instrument panel, pilot can observe his track by watching a tiny, coordinated airplane move over a map.

During World War II, several methods for determining position in flight were developed and used. Two of these are Loran and Shoran, used for long and short range navigation, respectively. In these systems, the navigating aircraft sends out a radio pulse to three ground stations. The stations return pulses to the aircraft which are analyzed by electronic means to determine their comparative times of arrival. This information is used in conjunction with a special map, with grid coordinates, to determine the plane's location. Loran, which utilizes medium radio

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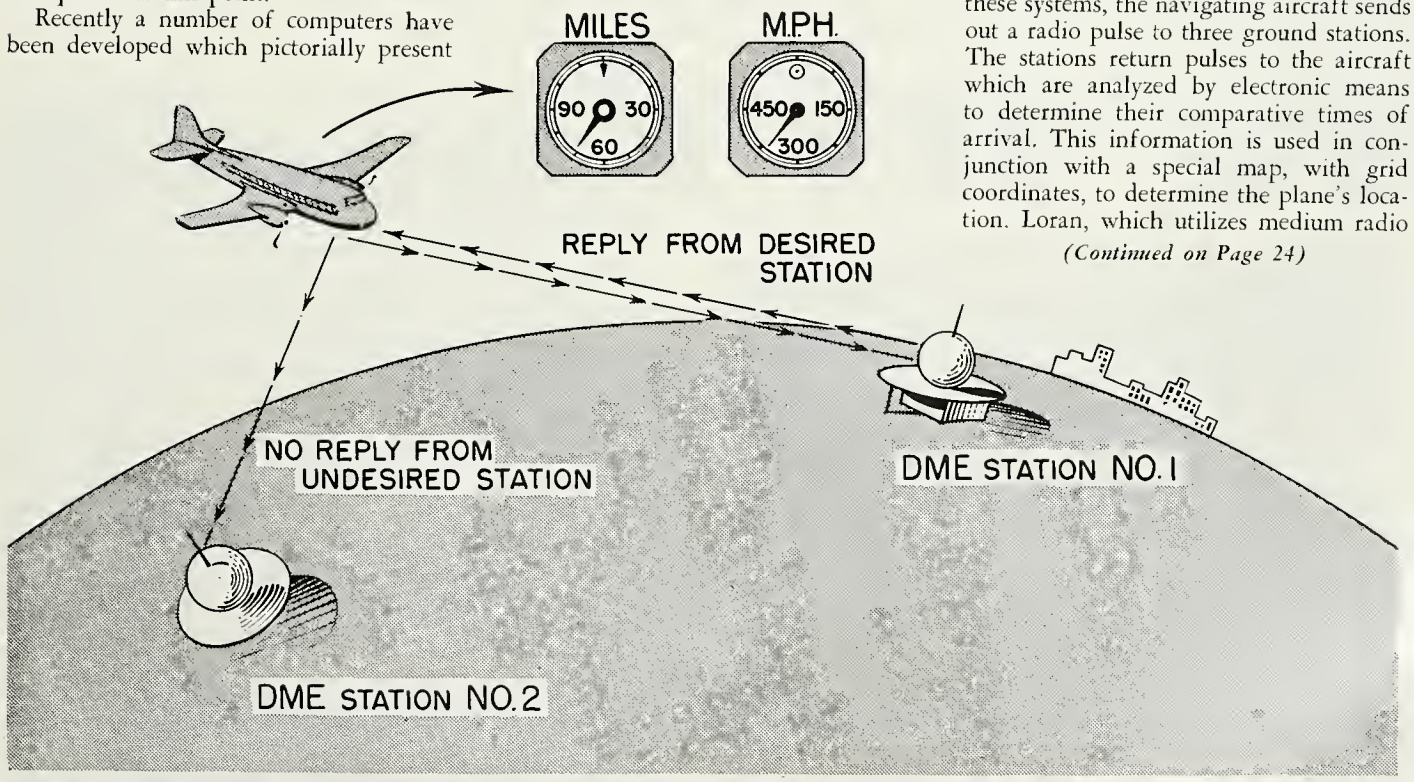
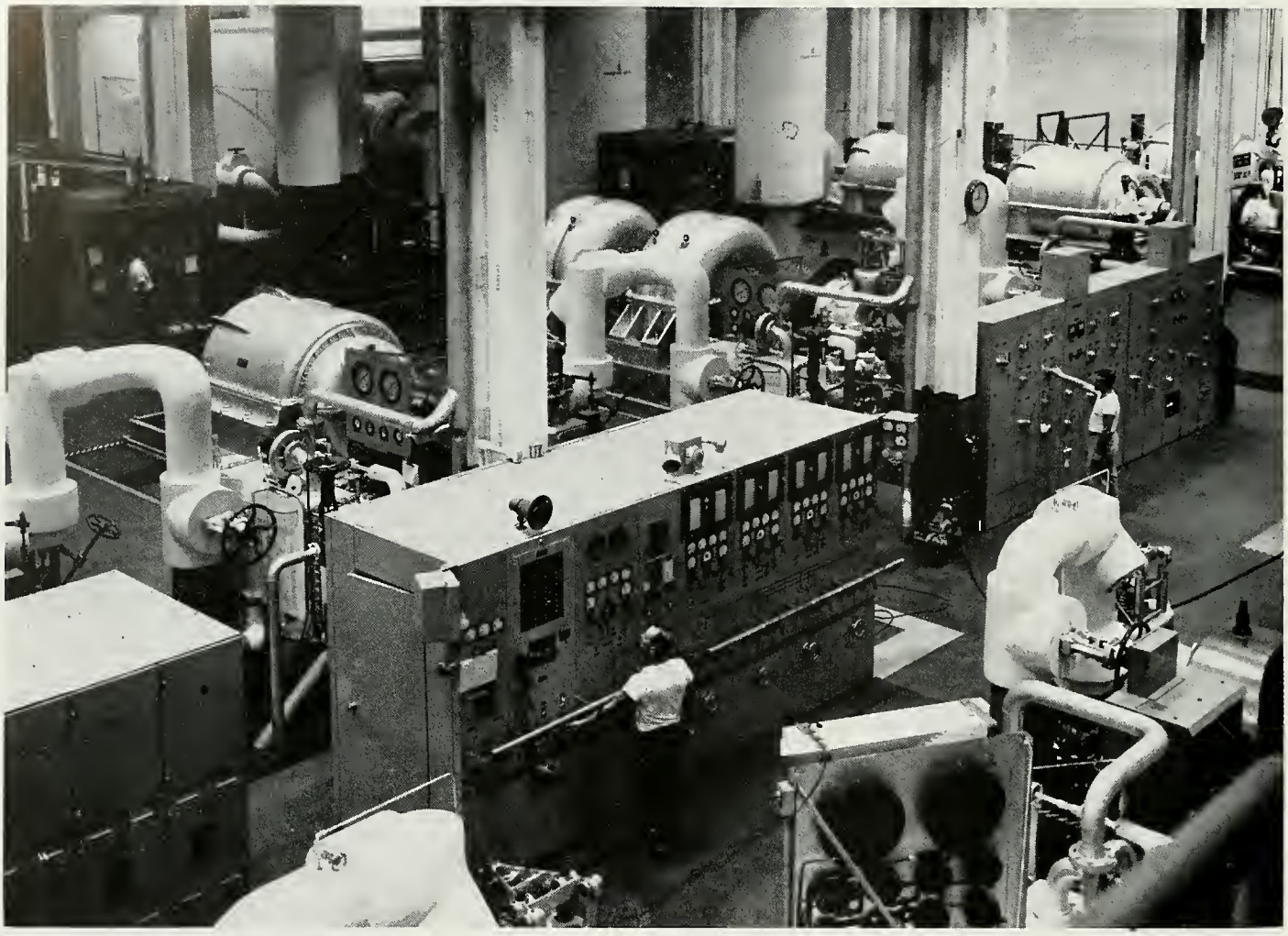


Latest aid for navigators is DME which is an accurate electronic speedometer, providing continual ground speed and distance data.



These giant refrigeration units pipe air to test cells in Pratt & Whitney's Laboratory where 55,000 ft. altitudes are simulated.

The JET Transport

by William P. Gwinn, General Manager, Pratt & Whitney Aircraft Division United Aircraft Corporation

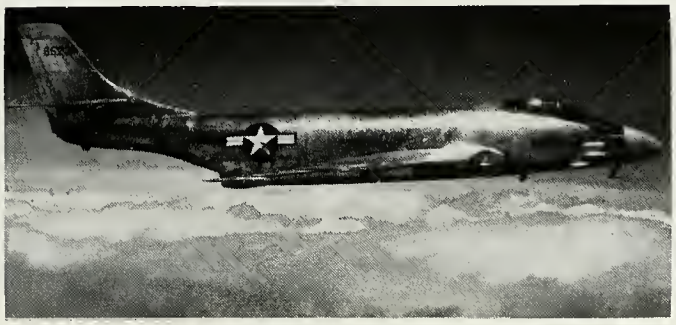
THE power of jet engines has increased with amazing rapidity since the end of World War II. As one new model after another has made its appearance, engine power has jumped to successively higher stages in a way that we would never have believed possible when we were working with the piston engine. Specific fuel consumption has been another matter. Not until just recently have turbojet engines appeared which promise, under certain flying conditions, to curb their appetites for fuel to the point where they may eat at the same table with the piston engine.

The triple objectives of high power, low fuel consumption, and low weight have been sought by all jet engine builders since the first aircraft powerplant of this kind was devised. We in Connecticut began moving toward these three goals —and a fourth goal of dependability— as soon as the pressure of piston engine production for World War II subsided and we were permitted to get into jets.

With World War II over, the first real engineering work on axial-flow turbine type engines of the company's own design—our T-34 propeller turbine and our J-57 jet—were begun. Long experience in developing piston engines convinced us that we could not possibly begin turning such turbine type engines out of our plant in less than 5 years of the most intensive kind of work.

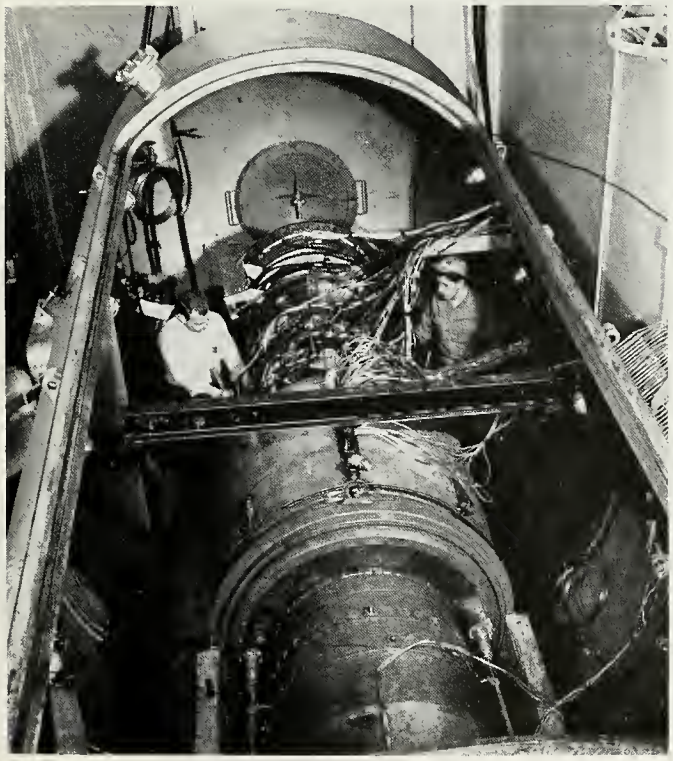
(Continued on Page 28)

The warld's largest jet bombers, Boeing B-52s, fly aver majestic Mt. Rainier. Weighing over 300,000 pounds, each of these mammoth, swept-wing aircraft is powered by eight Pratt & Whitney J-57 engines.



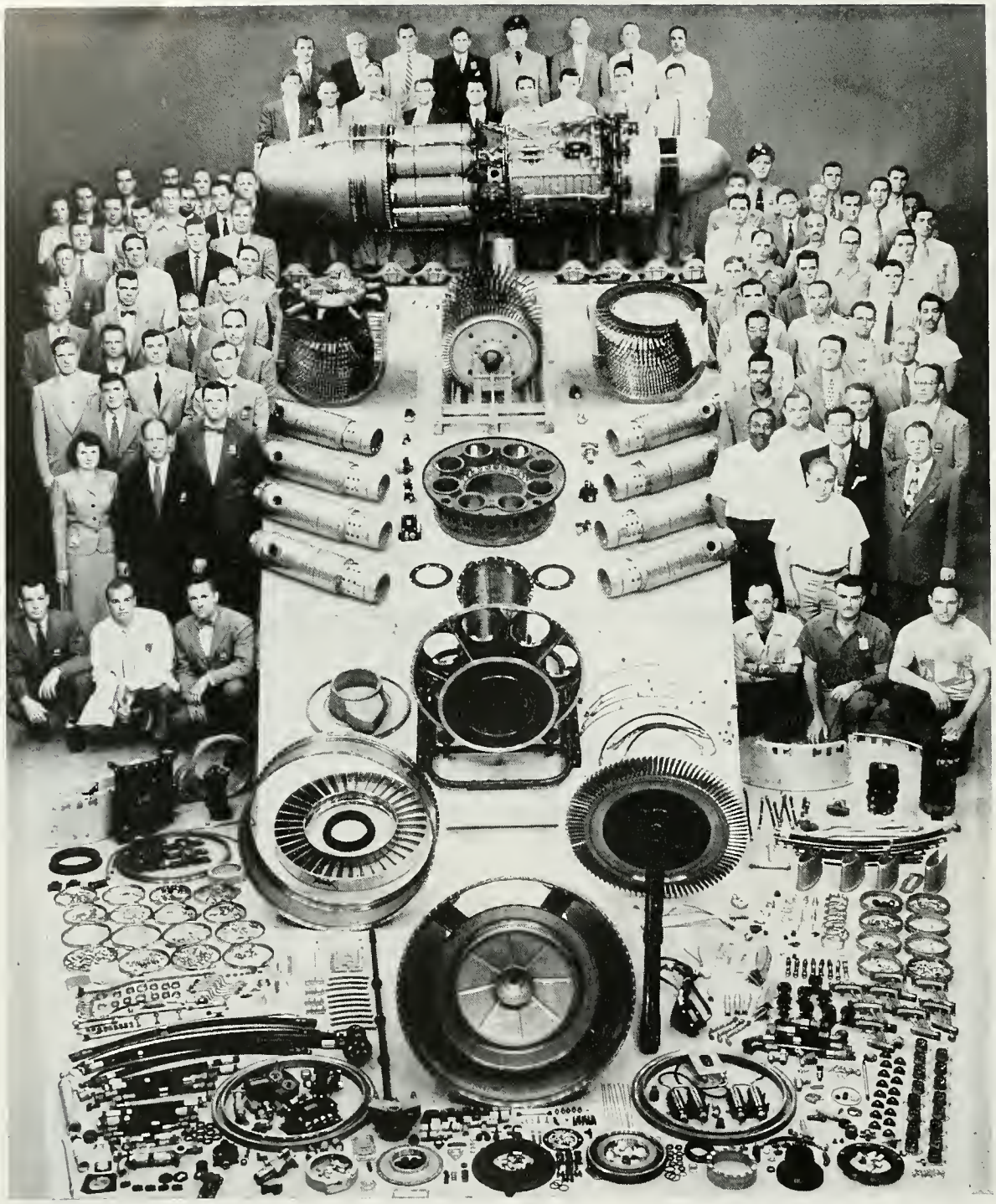
Reputedly equipped with the Pratt & Whitney J-57, this is the flying pratatype of the McDonnell F-101A Voodoo — Air Force strategic jet fighter. Recently announced North American F-100 Super Sabre is also powered by the J-57.

Simply flying faster is not enough--America's future jet airliners must also be safe, efficient and profitable



An axial-flow engine is readied far testing in this P & W test chamber at Willgoos Laboratory. Tests can include simulated "flights" to 55,000 ft. altitudes with temperatures from 70° below zero to 100° F.

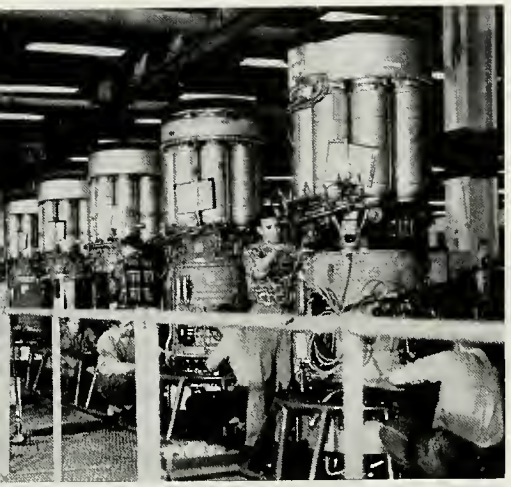
Whining like 10,000 banshees, this J-57 jet engine pushes a Boeing B-50 bomber at 370 m.p.h. The B-50's four propellers have been feathered. The J-57 was lowered from the bomb-bay after the "flying test bed" reached the 20,000 ft. altitude.



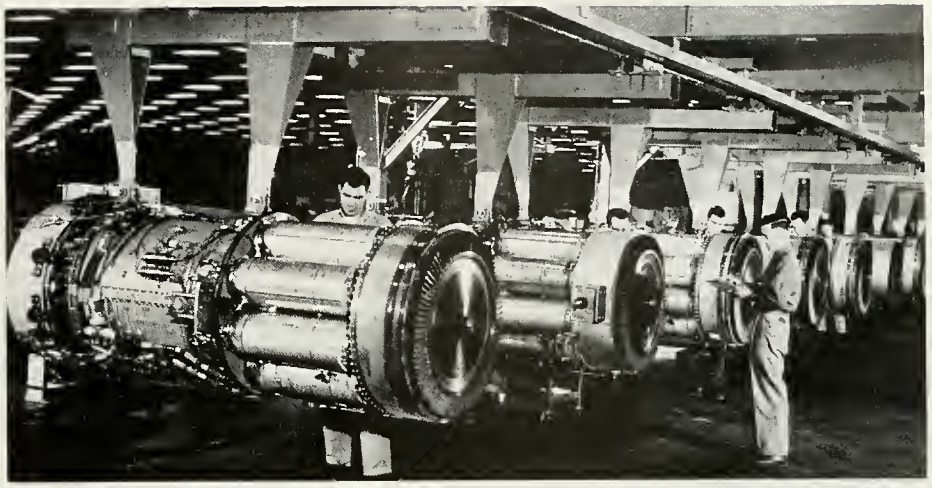
Gathered together in this remarkable General Electric photograph are the 8854 parts and 87 skills which go into the designing and building of each J-47 jet engine. Ryan builds most of the sheet metal parts.

20,000 JET ENGIN

General Electric's J-47 jet stream is 45 miles long



To sove floor space and avoid engine sag, G-E uses novel vertical assembly methods.



In what is probably the first completely mechanized jet engine conveyor system, G-E moves J-47 engines through the plant on overhead conveyors to speed assembly time.

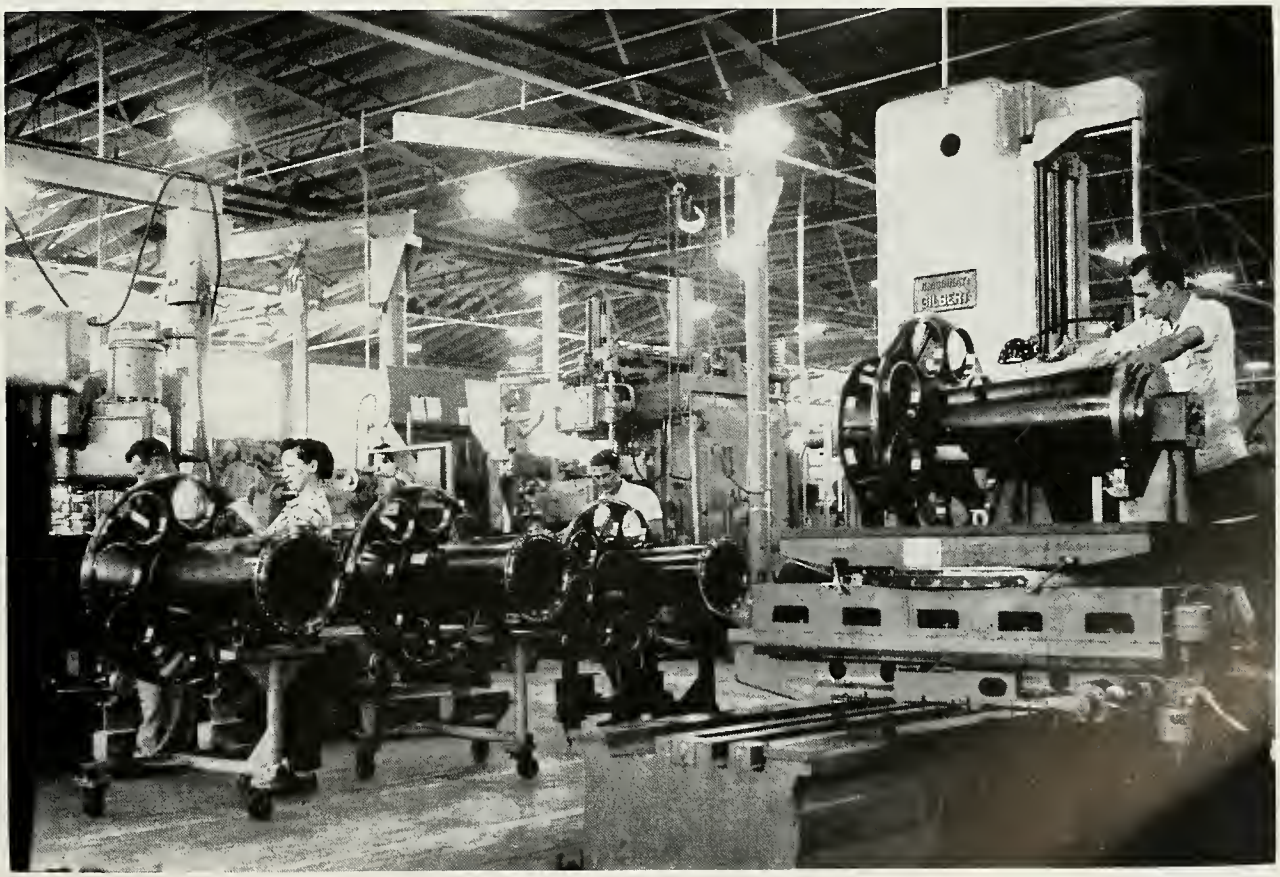
THE soldiers of the armies of Caesar, Napoleon and George Washington could marshal only a few thousand horsepower as they went into battle. This energy came from the one-tenth horsepower per man generated through muscular effort. One of today's jet engines can exert more power, in terms of thrust, than the combined effort of any of these famous armies.

Warfare has always involved the hurling of men, metal and destruction against the enemy. The side which could do this in the fastest, most efficient manner usually won the battles.

In the dynamics of modern, technological warfare, the movement of men and materiel and the hurling of destruction becomes a matter of mechanical horsepower. It is estimated that America's armed might in these terms, available in 1944 to win World War II, was well over one billion horsepower. This power

(Continued on Page 27)

Among the key components which Ryan builds for the J-47 are these aft frames which are the "back-bone" of the engine. With 150 feet of welding, 220 drilled holes and many closely machined surfaces, they are extremely tough to make.



ES

U. S. Navy tests Ryan's new cockpit arrangement

A BASICALLY different idea in the primary training of military pilots, as well as a new airplane, is being thoroughly tested by the Navy in its constant search for improved aviation techniques.

For the first time in flying's half century, instructors and students are seated side by side in a military primary training plane—a revolutionary change from the conventional "fore-and-aft" tandem arrangement.

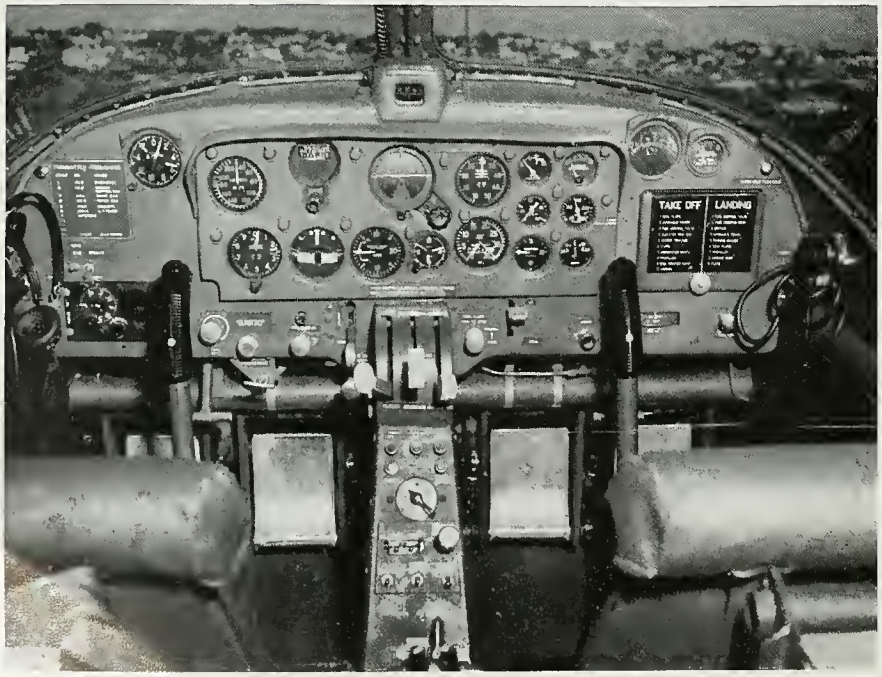
The plane that has introduced this new approach, based on highly practical factors, is Ryan Aeronautical Company's "Model 72," a military version of the famed commercial Navion. Pioneering new ideas in military pilot training is not new to Ryan. In 1939 the company introduced the PT-16 and PT-20 models, first low-wing trainers ever used for the initial instruction of U. S. military pilots.

The bright, orange-colored side-by-side "Model 72" trainer is exciting considerable interest at the Pensacola, Florida Naval Air Station, where it has entered a unique competition and series of evaluation tests being conducted by Headquarters, Naval Air Training Command.

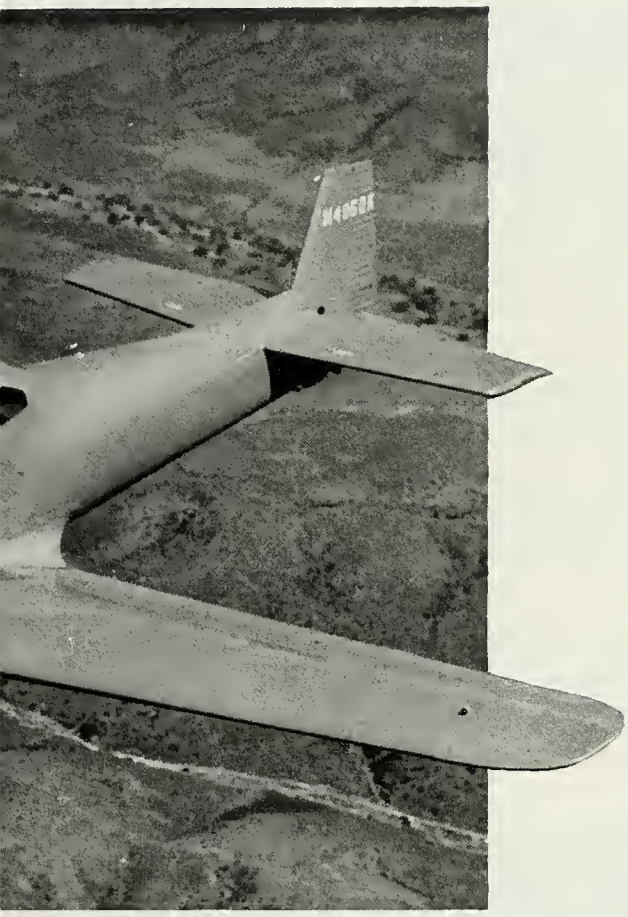
RYAN'S NEW MODEL 72 NAV
(A bubble canopy is now in

SIDE-BY-SIDE: A NEW IDE

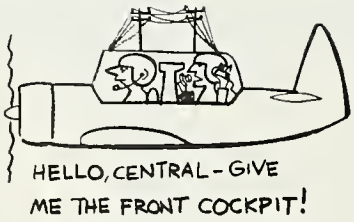
The new cockpit arrangement on the Ryan "Model 72" trainer is strictly military, with stick controls instead of wheels used on previous Navion models.



INSTRUCTOR AND STUDENT
FROM SAME VIEWPO



E-BY-SIDE PRIMARY TRAINER
plane flying at Pensacola.)



Training tandem style evolved with the development of the airplane from the Wright Brothers' first model to early biplane types with a long, thin fuselage. The only place to put a student was in a second cockpit, either fore or aft of the instructor.

This arrangement prevailed in military trainers for nearly 40 years until Ryan engineers, well aware of the advantages of side-by-side training as confirmed in checking out hundreds of private pilots in the Navion, redesigned the commercial Ryan Navion to military standards for the Navy's current primary trainer competition.

The improvements provided by the Ryan Model 72 military trainer include six major categories:

1. *Visibility.* The instructor, when seated behind the student, often has obstructions that momentarily block full vision, perhaps at critical moments. Seated beside the student, both he and the student have complete visibility in all directions, permitting safer operation of the plane. The reference points for take-offs, landings and flight maneuvers are identical for student and instructor.

2. *Observation of Student.* The instructor is readily able to observe student reactions before the evidence appears on

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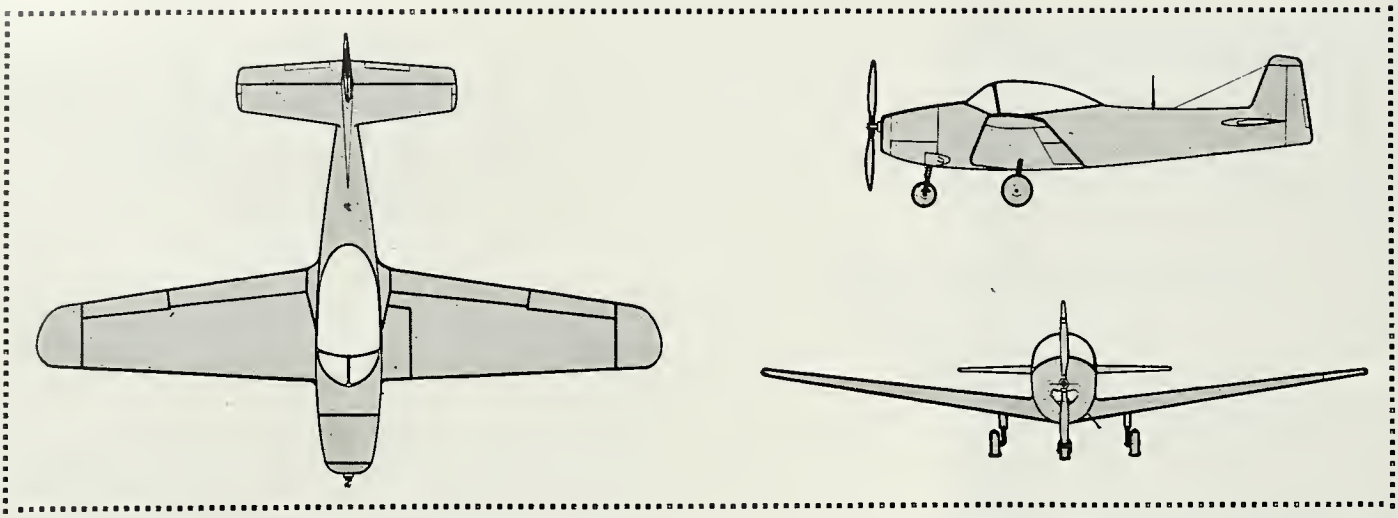
A IN PRIMARY TRAINING

Key personnel in "Model 72" project, Dave Williams, Walt Balch, Pete Girard, Jack Lucast compare notes on plane's flying characteristics after test hop.

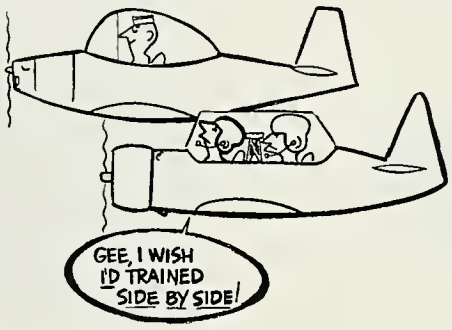


the instrument panel or in "frozen" controls. Gradually developing symptoms of other than normal behavior are quickly noted. Conversely, the mere proximity of the instructor to the student instills confidence in the beginner.

3. *Demonstration.* The actual mechanics of instruction are more readily shown in a side-by-side trainer. Cockpit procedures, take-offs, landings and flying maneuvers are easily explainable, verbally and with gestures, when the student and instructor are seated side by side.

4. *Communication* No interphone is needed in the Ryan "Model 72." Direct communication is possible only in this type of primary trainer. There is no chance of misunderstanding instructions or directions. With the instructor seated next to him, the student also feels encouraged to ask more questions. The effort devoted to communication is negligible.

5. *Evaluation.* By observing his student at closer quarters, the instructor can



evaluate his progress and ability more readily, can determine a fledgling pilot's capacity for progress, and can save time and money by weeding out the unsatisfactory student sooner.

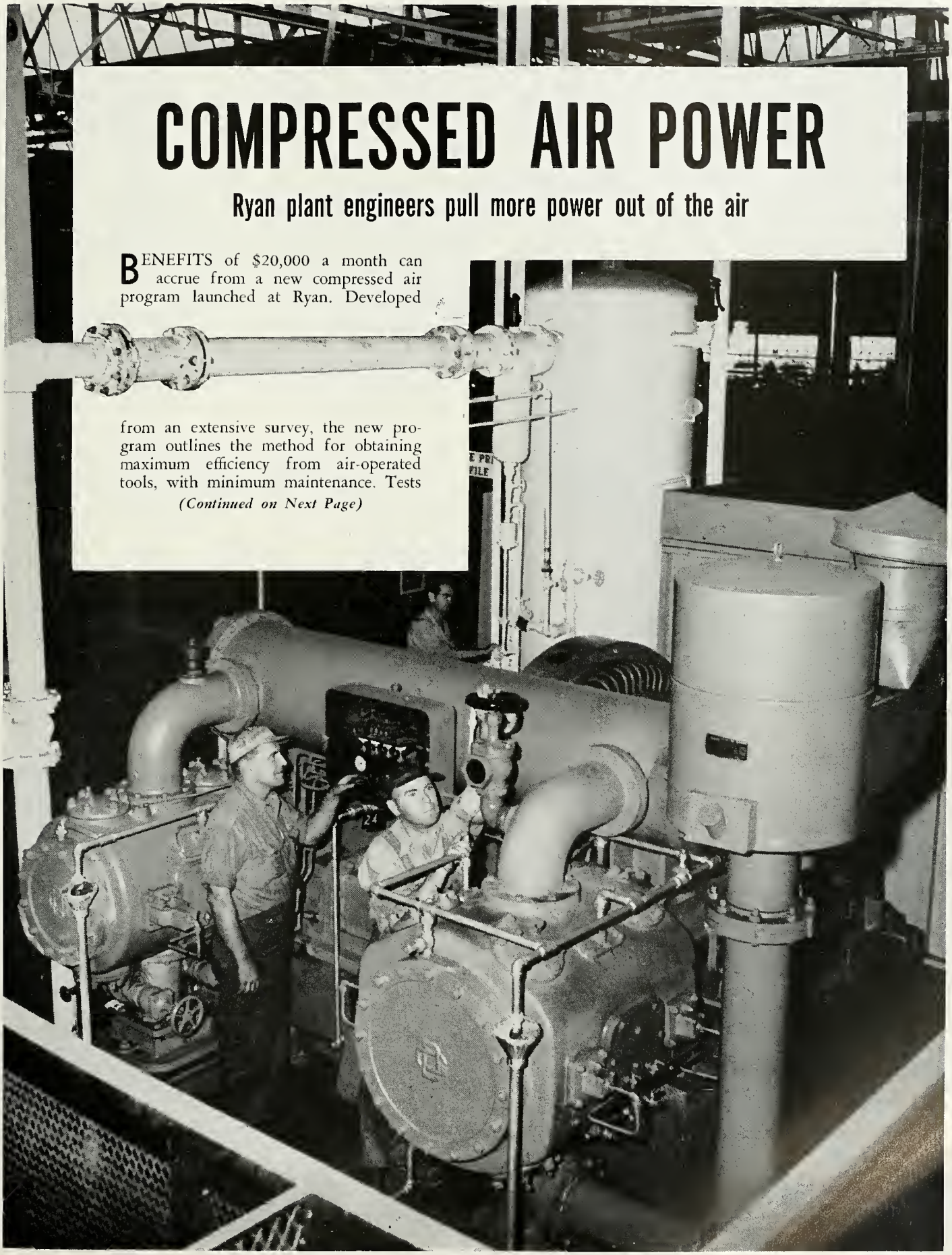
6. *Equipment.* There is no need for duplicating engine and flight instruments, or providing two sets of landing gear, flap, cowl flap and radio controls, and other equipment, such as required in a tandem arrangement. Nor is there the ever-present danger of differences in instrument readings which could lead to embarrassing, if not dangerous, situations. The side-by-side trainer, without duplicate cockpit items, has fewer maintenance and supply problems.

To convert the commercial Navion into a military trainer with aerobatic and other performance characteristics required by the Navy, meant a well-planned design modification program. There was a sense of urgency at the Ryan plant, and need for speed in meeting deadlines. With the engineers, mechanics and assemblers working day and night, the job was completed in about sixty days from the July go-ahead signal to the September take-off from Lindbergh Field for Pensacola and the evaluation tests.

To make the plane adaptable to military training and meet the aerobatic category under Civil Air Regulations, Part

(Continued on Page 25)

Peter Girard, aerodynamicist (in cockpit) and Dave Williams, project engineer, confer before "Model 72" takes off for Pensacola.



COMPRESSED AIR POWER

Ryan plant engineers pull more power out of the air

BENEFITS of $20,000 a month can accrue from a new compressed air program launched at Ryan. Developed from an extensive survey, the new program outlines the method for obtaining maximum efficiency from air-operated tools, with minimum maintenance. Tests

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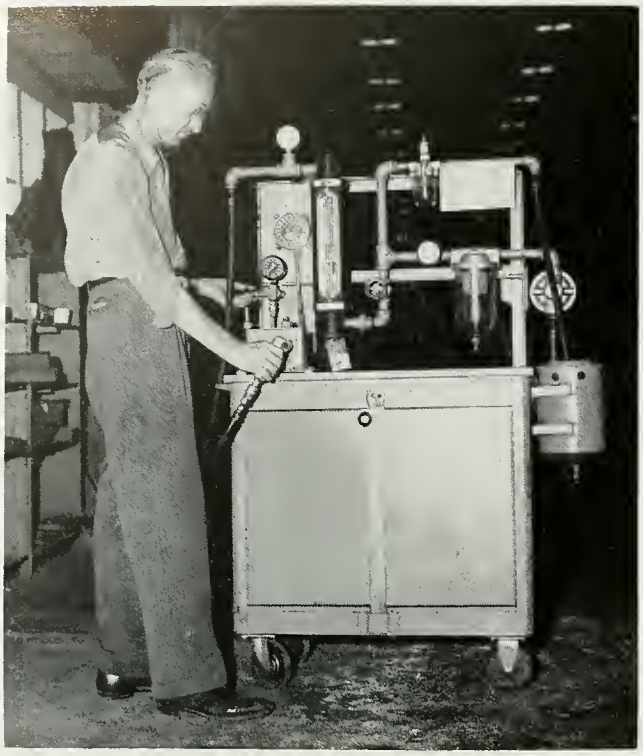
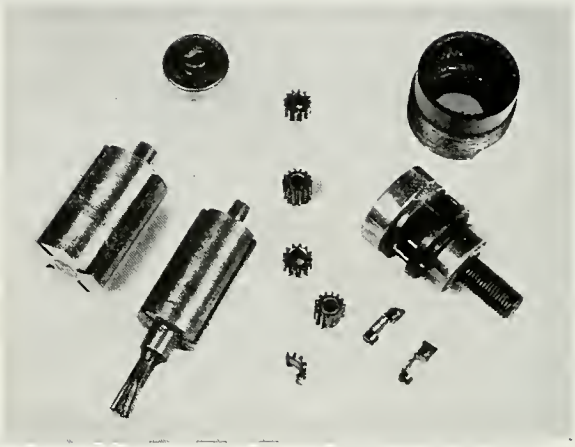




Typical damage to air tool motor caused by lack of lubrication. Small parts were almost worn through and rotor splines twisted by the time gears failed.

Air tools are tested and oiled in the plant with this Ryan-designed test cart which makes weekly rounds. Operated by Ivan Sears, the cart saves time, catches trouble early and tests air lines.

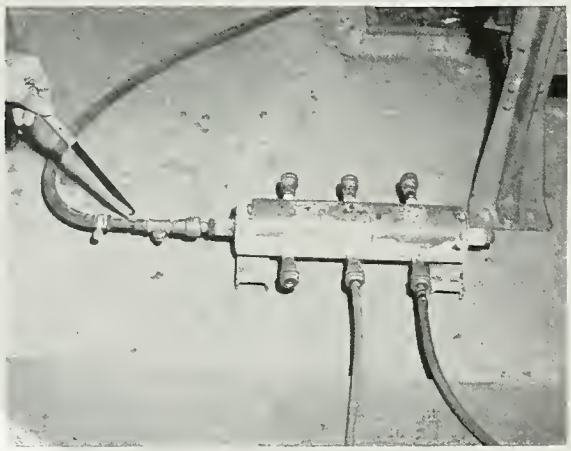
show that these substantial savings may be realized from increased production and reduced operating costs.

Because it is a silent, unseen source of power, compressed air is too often taken for granted. Yet it is a potent production force which deserves expert analysis. For instance, at Ryan 680 horsepower is required to obtain the compressed air used by air-powered tools. These include 4,000 hand-operated drilling, riveting and grinding tools as well as Ryan's 95 resistance welding machines, huge Cecostamp air hammers and pressure test stations.

Economically, too, the use of compressed air at Ryan involves substantial amounts. More than $2,000,000 a year

George Bullerwell uses a pneumatic grinding tool to remove excess weld metal from a Ryan exhaust system section of stainless steel. Ryan has 4,000 air-operated tools for drilling, riveting and grinding.

Methods engineer points to ¼-inch air inlet which unduly restricts power supplied to six tools from this Ryan "pig." Also plug has replaced drain cock.



in wages is paid to just those employees using air-operated tools. In addition, an amount of $82,600 yearly is expended for parts and labor required to keep Ryan's $300,000 worth of air hand tools in good operating condition.

Due to this growing importance, it was deemed advisable to undertake a detailed analysis of compressed air operations. Started several months ago, by the methods engineering department, this study has been completed and the recommendations made are now being carried out.

Under the direction of methods engineer John Roush, this survey disclosed some interesting things with respect to the tools, distribution lines and sources employed in the compressed air activity.

TOOLS

The pneumatic hand tool is a precision instrument which has a long life if properly cared for. In most tools, such as drills and grinders, the only parts which should wear under proper use are the rotor blades. However, it is mandatory that the tools be regularly lubricated. When lubrication ceases, tool damage begins. One damaged or worn part soon affects others and expensive gears and bearings become involved. The cost of rehabilitating a tool which has broken down because of defective lubrication may well run between $50 and $75.

It was shown by the survey that expensive tool repairs could be avoided in almost every instance if a system were adopted which insured the regular lubrication and testing of each tool. Testing is important because frequently a tool will become faulty but its defection will not be apparent to the user. Consequently, he will continue to use it, causing further wear or damage and resulting in loss of production time because the tool is not putting out at its rated capacity.

In order to accomplish the lubrication and testing of tools without discommoding production, an ingenious mobile test cart was devised. Equipped with test instruments and oiling devices, these carts travel through the factory to bring the analytical facilities to the tools in use.

Every Ryan air-operated tool is tested each week. First, the tool is checked on the test cart's tachometer to determine its RPM. Then, a flow meter check is made to analyze its capacity to handle cubic feet of air per minute. By harnessing the tool to a hydraulic pump which pumps oil against a pressure guage, a good idea of the power which the tool develops is obtained. Finally, the tool

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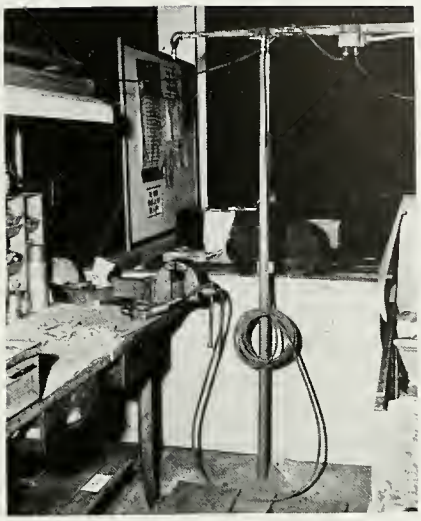
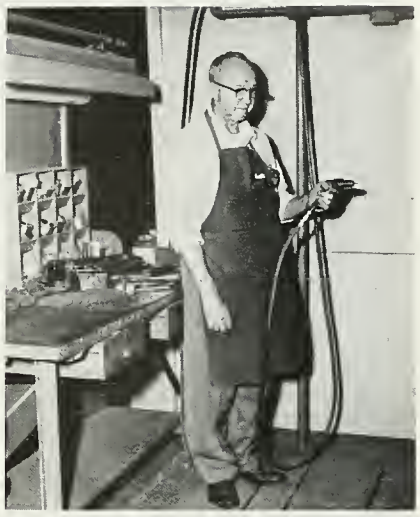
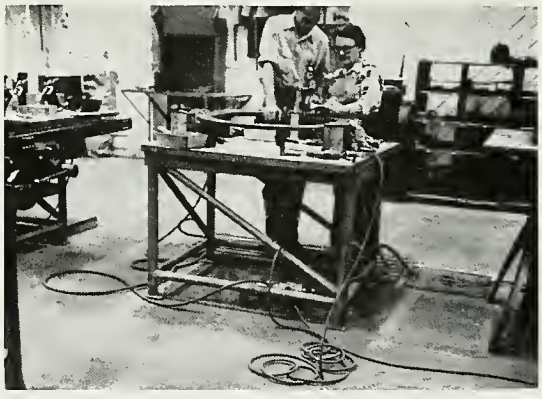


Unnecessarily long hose and taking hose from bottom of feed pipe mark this as an ill-advised installation.

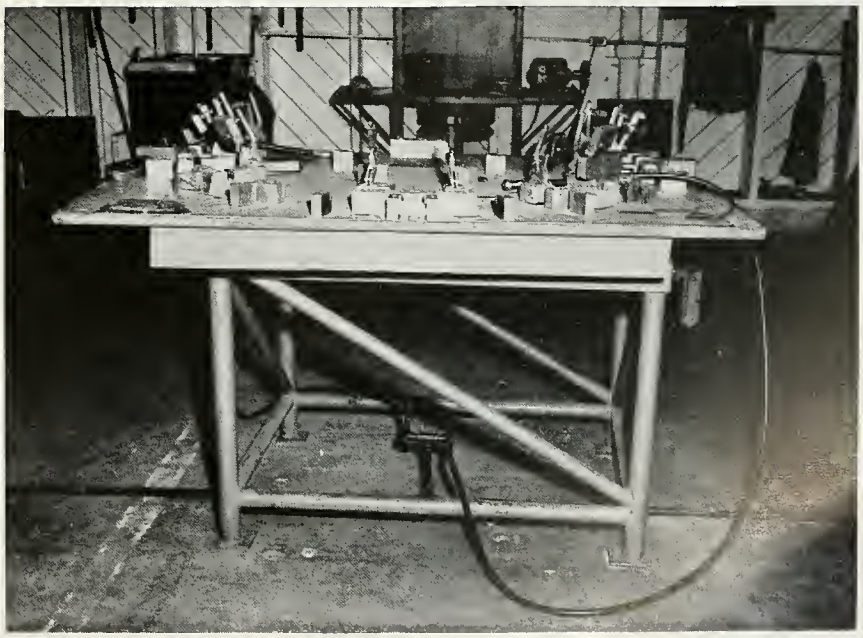


Bruce Tomlinson has a more powerful drill with correct length hose. By top take-off, water trap is avoided.



Excessively long hoses in this set-up cut down tool power in two ways. Friction is caused by long runs and by coils which are required to keep hoses out of way.

Substantial savings in power loss, increased facility in handling air tools and reduced floor hazards are provided by this correction of the situation shown above. Often, air feed lines can be incorporated within fixture frames.



Like a TV station controller, George Subisky watches a television screen to monitor the performance of a Pratt & Whitney engine.

JET CELL-MATE

Pratt and Whitney takes TV where engineers dare not go

New, compact TV camera is adjusted by Arnold Waterman prior to jet test run.

ALTHOUGH they won't supplant Dagmar or Berle, jet engines may soon become star television performers. Experiments are under way at Pratt & Whitney Aircraft to use television to observe hot-running jet engines in test cells. Potentially, this new technique could effect a sharp increase in jet research knowledge.

Because they operate at red hot temperatures and contain furiously rotating masses of metal, experimental jet engines must be tested in monolithic concrete test cells. Engineers can observe these power plants through small double-glass windows. With the engines mounted in fixed positions, it is practically impossible to examine more than a small part of the engine at any one time.

With television viewing equipment, this hampering restriction may soon be removed. For two years a group of Pratt and Whitney electronic specialists have been studying this application. Headed by Arnold Waterman, assistant project engineer, the group includes Charles Wilkins, experimental test engineer and Ernest Amiot, development technician.

Starting with specially constructed television camera and accessories, the group began their experiments at the Andrew Willgoos Laboratory. One of the first difficulties encountered was that imposed by the cumbersome coaxial cable. Measuring about two-and-a-half inches in diameter, this bulky cable would transmit a satisfactory image for only 35 to 50 feet.

(Continued on Page 24)

Deadly Sky-Sweeping

Guided missiles and the gun with the built-in "brain" will track "Firebees"

WHEN U. S. Army troops begin their use of Ryan's spectacular "Firebee," pilotless, jet-propelled drone, as a target plane, anti-aircraft gunners will test the full potentialities of the new 75 mm Skysweeper, a remarkable weapon with a built-in "brain."

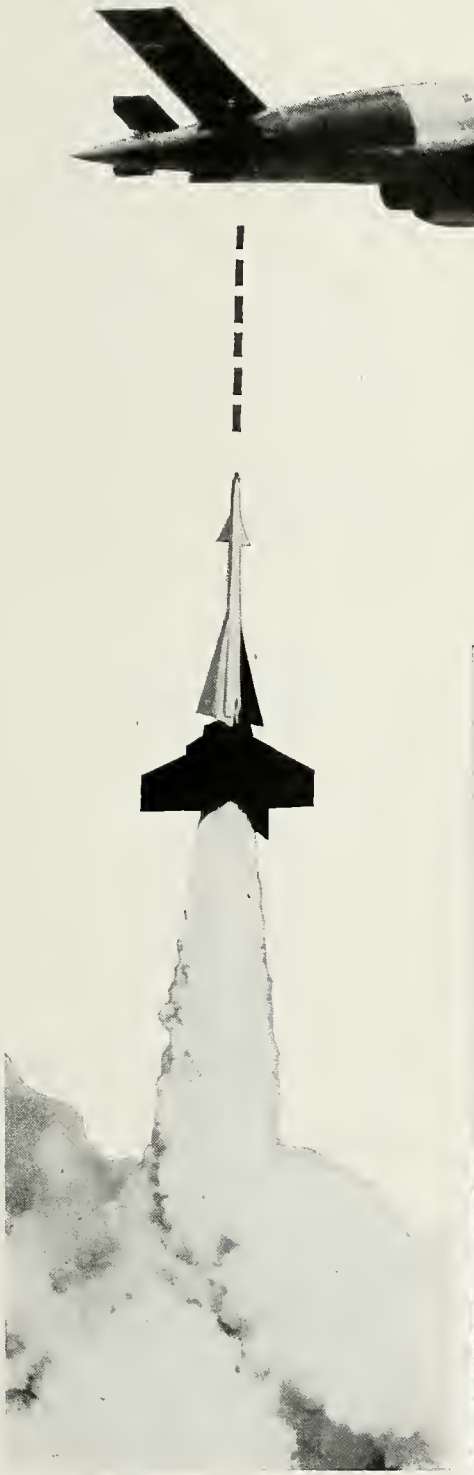
Army defenders also will pit against the "Firebee" the latest in guided missiles, such as the "Nike," many details of which are still restricted.

Production of the XM21, Army Ordnance designation for the "Firebee," is under way at Ryan for test use in a.a. gunnery practice at Fort Bliss, Tex., and guided missile testing at the White Sands Proving Grounds, N. M.

The 10-ton "Skysweeper" contains radar that automatically swings the gun on target. This "brain" can spot enemy aircraft fifteen miles away and can bring them down at four miles even at zero visibility. A target plane would be automatically sub-

(Continued on Page 23)

U. S. Army Photos



Ryan's spectacular XM21 "Firebee," jet-propelled pilotless target drone now under production for Army Ordnance, will be tracked by Army anti-aircraft guided missiles, such as the one shown at left, roaring upward at supersonic speed, and the new "Skysweeper" 75 mm artillery machine gun in future training of anti-aircraft ground crews. "Firebee" can simulate fast fighter's evasiveness.

COMPRESSED AIR POWER

(Continued from Page 19)

is oiled. If defects show up in the tests, the tool is sent to the repair station for repairs.

In conjunction with the Ryan development laboratory, a special test is being conducted to determine if molybdenum disulphide can be used as a tool lubricant. If this compound stands up as well as preliminary tests indicate, it will be possible to clean and re-lubricate the tools without dissembling them. With the standard greases now used in tool bearings and gears, this cannot be done because the cleaning solvent washes the lubricant away. The tool then has to be taken apart and regreased. If molybdenum disulphide proves to be entirely satisfactory as a tool lubricant, the tools may be serviced completely at the test cart, without dissembly, because this new lubricant is not dissolved by cleaning solvents.

DISTRIBUTING LINES

Ryan factory buildings, covering over 750,000 square feet of space, are adequately served with compressed air. The desired objective is to see that a full 90 pounds per square inch pressure is brought to each hand tool. Tool manufacturers have standardized their equipment on this air pressure. They state that a tool will lose power if air pressure drops below 80 psi and that undue wear will ensue if pressure goes above 110 psi. Power loss can materially affect production output. For instance, Ryan found that a typical tool could produce 18 parts at 90 psi but only 14 when air pressure dropped to 70 psi.

One of the most revealing aspects of the Ryan survey were the pronounced effects which fittings and hoses had upon tool performance. Ryan uses 3,000 quick-disconnect type fittings. These should be inspected at regular intervals. After months of service, the rubber washers and metal valves in them can become worn and greatly restrict air passage. Their effect on tool operation is shown in the following list of tests:

Percentage of tool efficiency

Line PSI	With old valve and washer	With new valve and washer	Percentage efficiency increase
95	48%	100%	108%
98	80%	100%	25%
95	6%	90%	1,400%
100	27%	88%	225%
102	5%	100%	1,900%
* 80	25%	56%	124%
* 85	41%	56%	36%

*Low line pressure

By specifying the best type of fittings, these losses can be held to a minimum. The pressure drop through a good quick-disconnect fitting and valve is only 3 psi or 5 percent in tool efficiency.

A number of instances of power loss due to improper size and length of hose used were uncovered by the study. The smallest inside diameter rubber hose recommended by air tool manufacturers is 5/16". Often ¼" hose sizes are used and no consideration is given to lengths employed. Tests proved that as much as 1 psi per foot of hose is lost when diameters are slightly undersize. In some cases it was found that 25 feet of hose were used to serve a work station only 6 feet from the air outlet. A gain of 2 psi was made by merely uncoiling such hose.

A typical situation which can occur is one in which a ¼" hose from an air outlet is plugged to a hose of larger diameter which, in turn, is connected to two or more whip hoses for tools. Here, the capacity of every tool is limited by the first undersized hose and further reduced by the lengths and multiple fittings used. In such a case, tool efficiency was increased 42 percent by merely removing the first hose. Examples of the gains made by substituting ⅜" diameter hose for ¼" are shown in the following test tables:

Line PSI	Tool Efficiency ¼" I.D. Length	Tool Efficiency ⅜" I.D. Length	Percent increase
106	76% 12′	100% 12′	31.5%
94	33% 20′	92% 12′	178.7%
94	49% 14′	92% 12′	87.7%
98	46% 14′	90% 12′	95.6%
94	67% 8′	92% 12′	37.3%
100	36% 15′	100% 12′	177.7%

Basically, Ryan's main compressed air lines were found to be adequate but branch lines were sometimes improperly arranged. For instance, it was found that ¾"diameter overhead plug strips were fed by ¼" branch lines. In one case a greatly extended branch line was feeding 34 outlets even though another source of air was close at hand. A common practice was to take the tool outlet from the bottom of the feed pipe, tending to make a water trap out of the outlet.

Ryan uses a good many manifolds, or "pigs" which consist of a short length of 3-inch diameter pipe with a main inlet in one end plate and a drain cock in the other. Six fittings are installed in the barrel to serve tools. Tests showed that these "pigs" could function efficiently when connected to branch lines through ¾" hose and ½" pipe fittings. Without proper supervision, these units are often converted so that they do not meet these requirements. Sometimes, the drain cocks are removed and a plug or another air fitting is inserted in its place, so that they cannot be drained.

As a direct result of the study, Ryan has standardized on the use of Hansen fittings and ⅜" diameter hose lines of the shortest possible run to each work station. All fittings are inspected at regular periods and worn valves and washers replaced. Tapered valves have been replaced with square shoulder valves which permit an average of 14 percent more air to pass. Care is taken to see that not more than 10 Hansen fittings serve a ½" pipe inlet and hook-ups are distributed in as balanced a manner as possible. "Pigs" are served with proper sized hose and fittings and drain cocks were re-installed.

These steps have increased tool power as much as 200 percent and have made more compressed air available to the plant. This may sound paradoxical in view of the fact that larger air lines require more air to keep them supplied. As a matter of fact methods engineers estimate that it takes 35 percent more compressed air to fill the system now because of the enlarged hoses and fittings. However, with full power at each tool, the production jobs are accomplished in a fraction of the time formerly needed with the result that more air power is available to the plant.

AIR SOURCES

Four compressor stations are located in the Ryan plant to provide the necessary compressed air. Five Gardner-Denver compressors and one Worthington type are used to develop 3600 cubic feet of air a minute at 100 psi. The survey showed that this air entered the main lines of the plant at a temperature of 100°F. As it coursed through the plant and into the hand tools, it cooled and moisture in the air condensed within the system. This water caused rust which flaked off and was blown into the tools. The moist, dirty air entering the tools removed the lubricants and introduced foreign abrasive matter which contributed to excessive maintenance costs.

By improving the design and use of water trapping facilities, Ryan improved this undesirable condition. However, the survey recommended that steps be taken to remove the water from the air before it entered the distributing system. This has been done at one compressor station and is being planned for the others. A Parkhill-Wade air drier has been installed to remove the water content from the air. By means of a trichlorethylene glycol solution, through which the compressed air is flushed, two-and-a-half gallons of water per hour are being removed from the air.

(Continued on Next Page)

In addition to its drying action, the air drier also exerts a profound cooling effect. Instead of entering the main lines at 100°F., the air is now cooled down to only 40°F. Consequently, it warms as it passes throughout the plant instead of cooling. As a result condensation of water occurs on the outside of the lines instead of within the system.

To summarize, the basic benefits which the Ryan survey and the newly created procedures have produced are:

1—A desirable decrease in the cost of repairs to Ryan's 4000 air-operated hand tools.

2—A marked increase in the efficiency of these tools resulting in faster, better work and equivalent to increasing the work force.

3—An extension in the life of Ryan's $300,000 worth of these tools.

4—A stepped up availability of these pneumatic tools due to better service and reduced periods of out-of-service, equivalent to raising the number of such tools.

5—An increased availability of compressed air power within the plant equivalent to installation of added facilities. This is important because Ryan uses close to present compressor capacity.

SKY-SWEEPING

(Continued from Page 21)

jected to bursts of 45 rounds of 75 mm shells per minute. These high explosive shells, each weighing 12½ pounds, are armed with "proximity" radar fuses causing an automatic explosion at a predetermined distance from the target. The firing is remotely controlled by either the radar-operator or the computer-operator.

This is the Army's largest caliber automatic a.a. artillery weapon, literally an artillery machine gun, due to its rapid firing capabilities. And for the first time, an a.a. weapon has radar, computer and gun on one carriage, to provide full integration of gun and fire control in a virtual pushbutton operation.

The "Skysweeper" is so complex that its crews must take one of the Army's longest training courses for maintenance personnel, 48 weeks, at the Ordnance School, Aberdeen Proving Ground, Md.

And soon these crews will have a chance to test their skill against the near-sonic speed of the Ryan "Firebee," a pilotless air demon that can take the evasive action of any piloted jet plane. The sharpening of these skills in training against America's most successful target drone will further guarantee the nation's safety against surprise enemy air attack.

Operation: FACE LIFTING

Main entrance to administration building of Ryan Aeronautical Co., where new stainless steel sign has been installed, is impressively illuminated.

Ryan has become a more attractive place than ever in which to work. The factory buildings have been spruced up with the most extensive paint job since the plant was moved to its present site on Lindbergh Field more than a dozen years ago. And various signs, two of which are impressively illuminated, proclaim Ryan's location for considerable distances.

In addition, the interior of the building in which jet engine components are built, has been completely "redecorated" by a white paint job which has considerably brightened the working areas.

Giant floodlights have also been installed in the employees' main parking lot to provide maximum security for the vehicles at night. Parking facilities were improved considerably by asphalt paving of 20,000 square feet, thus substantially extending the area previously paved. Ryan's expanding payroll has brought the necessity of accommodating more automobiles of employees.

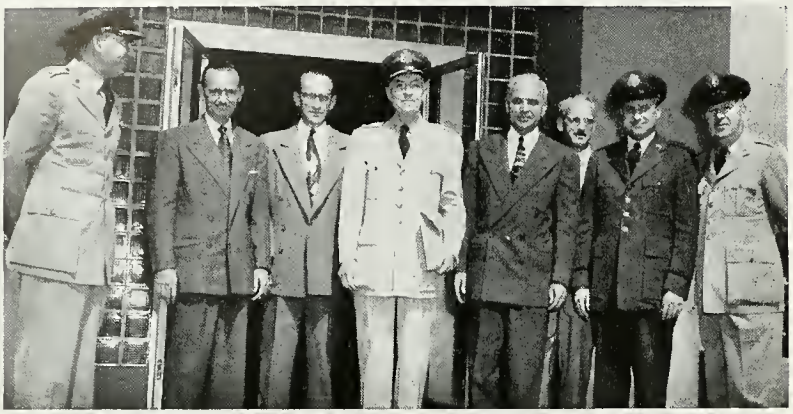
The most spectacular of the new signs is a green neon sign over 10-foot high painted black letters on the east wall of the final assembly building.

Another impressive sign, made of stainless steel letters, has been installed above the main entrance to the administration building and is floodlighted at night.

Tallest sign is on the north wall of the final assembly structure. The letters are 12 feet high.

Brilliant green neon sign over 10-foot high painted black letters can be seen for great distance.

Cover photo shows 40-acre area of Ryan's plant at Lindbergh Field, San Diego. Bay is in background.



Air Materiel Officers Confer At Ryan

Streamlined functions of the Air Materiel Command in a reorganization were explained recently to Ryan executives in a visit to the plant by top-ranking officers. The Los Angeles procurement district office has been abolished and all Air Force procurement and contracting activities affecting Ryan are now centered in the San Bernardino Air Materiel Area offices at Norton Air Force Base.

Shown at main entrance to Ryan administration building are, left to right, Col. Stephen P. Dillon, ranking Air Force officer, San Diego; Colin A. Stillwagen, Ryan secretary-treasurer; B. Kenneth Goodman, contract administrator and legal counsel; Maj. Gen. E. G. Langmead, commander of the San Bernardino Air Materiel Area; T. Claude Ryan, president; Curtis L. Bates, assistant director of engineering; Capt. Gordon B. Palmer, acting officer in charge of the San Diego procurement district; and Lt. Col. John Wilson, director of procurement, San Bernardino Air Materiel Area.

AIR NAVIGATION

(Continued from Page 9)

frequencies, is subject to static and bad weather interference. Shoran, using VHF bands, does not reach out to the extended distances which are available to Loran users.

Another very useful navigational aid is the Automatic Direction Finder. This device employs a loop antenna which is automatically rotated. With it, the pilot can tune in any standard broadcast, between 550 and 1600 kc, and home on the station. By picking up bearings to two stations, he can plot his position with little difficulty. When homing with ADF, a pilot's course usually results in a spiral-like track to the transmitter rather than a straight line because of the effect of winds.

All of these systems of navigation, from pilotage to Omnirange, are useful. Strangely enough as each new development has come along it has usually not caused the discard of previous methods but has been added to them. For example, many pilots are flying by means of all of these methods today. Each type of aircraft and aircraft use employs those systems which best lend themselves to the particular flight requirements. Using the finest equipment available, U. S. commercial airlines completed 96 percent of their flights last winter. Bad weather and mechanical troubles caused the 4 percent cancellation and this figure is now approaching an irreducible minimum.

But something more is needed and must be developed to meet the global military requirements. As pointed out, dead reckoning and celestial navigation are not sufficient to meet the need. Radio ranges, Distance Measuring Equipment, Loran, Shoran and Automatic Direction Finders depend upon ground facilities which cannot be relied upon for global use during military operations.

One other system suggests itself—radar. Radar systems can be entirely airborne. Holding out great promise as a result of its wartime use, radar has not completely fulfilled that hope as far as known navigational equipment is concerned. Radar mapping equipment is relatively heavy and its effectiveness depends upon the power, and weight, of the transmitter. It is useful over coastlines and other terrain where marked topographic features are discernable. Over water and flat plains, or other similarly featureless areas, radar mapping facilities are almost useless.

The global military pilot, or navigator, requires a navigational system which will provide the benefits offered by VOR/DME equipment without reliance upon ground facilities. This sounds like an almost impossible problem to solve but present electronics advances are giving this dream a semblance of reality.

With today's flight speeds, and those being designed into new aircraft, the modern pilot cannot be content with any method of navigation which depends upon periodic fixes or requires substantial time to obtain data. Flying over long ranges at high speeds, he cannot afford to deviate from his desired course.

The ideal military system, then, will be that which gives the pilot a continuous, visual indication which tells him three things: (1) that he is successfully making his desired track, (2) how far he has progressed in ground miles, and (3) his present position. It would be helpful, but not essential, to also know his ground speed. All these data must be provided from a self-contained system which comes within practical size and weight limitations.

JET CELL-MATE

(Continued from Page 20)

This distance was not enough to serve the large test cells.

Another difficulty which the group met was that of obtaining sufficient light of correct quality to illuminate the engine for the television camera.

Armed with extensive test data, the engineers have made substantial progress in overcoming these obstacles. A new "Dage" industrial TV camera was obtained. This instrument is extremely compact, measuring only twelve by fourteen inches. It is equipped with a new easy-to-handle coaxial cable which is only one-quarter of an inch in diameter and will transmit a distortion-free picture as far as 1000 feet.

Experiment has disclosed that the best lighting results are obtained by using banks of ordinary fluorescent tubes.

Working with the new equipment, Pratt and Whitney engineers are thinking in terms of using several television cameras within a test ceil. These would be mounted on mobile, rather than fixed, bases. As a new jet engine is being operated, the TV cameras would traverse the power plant, scanning it from every angle and sending the visual information to a remotely located television receiver screen surrounded by interested engineers.

This would uncover new secrets in the life of a hot-running jet engine which have heretofore only been guessed at because of the impossibility of actually seeing the complete power plant under test conditions. By focusing a motion picture camera on the TV screen, a permanent record of the various tests conducted can be made and used for future study.

SIDE-BY-SIDE NAVION

(Continued from Page 16)

3, required the airplane to be designed to a limit load factor of 6 Gs which compares with the standard commercial requirement of 3.8 Gs.

One interesting change is a new wing tip design of different contour which increases the span by four feet. The ten square feet of wing area added, and the decrease in span loading, results in still better flight characteristics and performance.

Span of the side-by-side trainer is 37 feet, 8 inches; and the length is 27 feet, 9 inches. Gross weight is under 3000 pounds compared with 2850 pounds for the commercial Navion.

The cockpit was transformed from four-place to two-place. In eliminating the rear seat, space was made available for a baggage compartment. The previous baggage compartment was converted into an equipment bay. A more rugged interior replaced the plush decor of the Navion personal and executive plane.

Stick controls were substituted for wheels, and rudder pedals with toe brakes took the place of the hand brake. The aileron and rudder interconnect system for "simplified flying" was eliminated. A free swiveling nose wheel, a training requirement, was installed so student could learn to steer with brakes only while taxiing.

In the "Model 72" sent to Pensacola for the evaluation tests, two additional windows were added to the windshield area and two to the canopy to assure "all-around" visibility. A full plexiglas bubble canopy would be standard, however, in the production model.

A controllable rudder trim tab was added so the student need not hold the rudder pedal against the engine torque during climb and take-off.

The entire cockpit arrangement was redesigned to provide an easily accessible central control pedestal and console between the seats.

Military type shoulder harnesses and safety belts are provided. A tuneable VHF receiver, a range receiver and three VHF transmitters constitute the radio equipment, making available 15 channels for transmitting.

The Navion's controllable pitch propeller was replaced by a constant speed prop. An auxiliary fuel tank was added.

The "Model 72" is designed to utilize the Continental O-470-A, O-470-13, or the Lycoming GO-435-C2B engine. The latter engine is installed in the prototype

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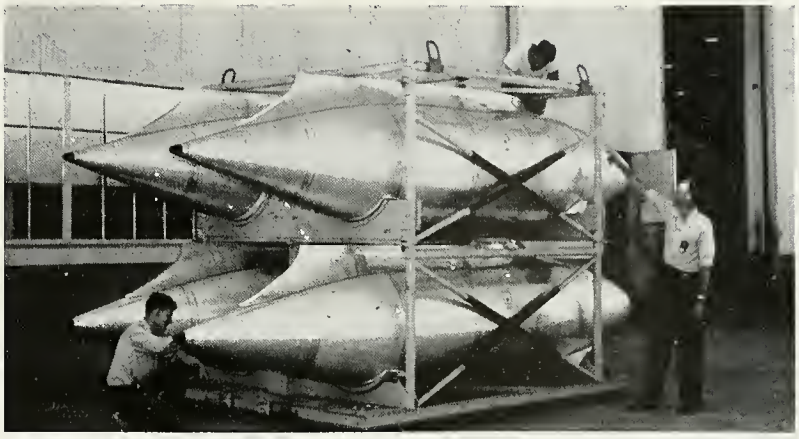


Specially designed fixture carries four fuel tanks for shipment by rail.

TANKS FOR TANKERS

A new type of external fuel tank has gone into quantity production at Ryan Aeronautical Company, and shipments are now under way to Boeing Airplane Company plant in Seattle, Wash.

These tanks, to be used on the KC-97G aerial tankers in order to increase their range and fuel-carrying capacity, are somewhat smaller than the tanks Ryan built for the Boeing B-47 bomber. These were the largest of their type in the world.

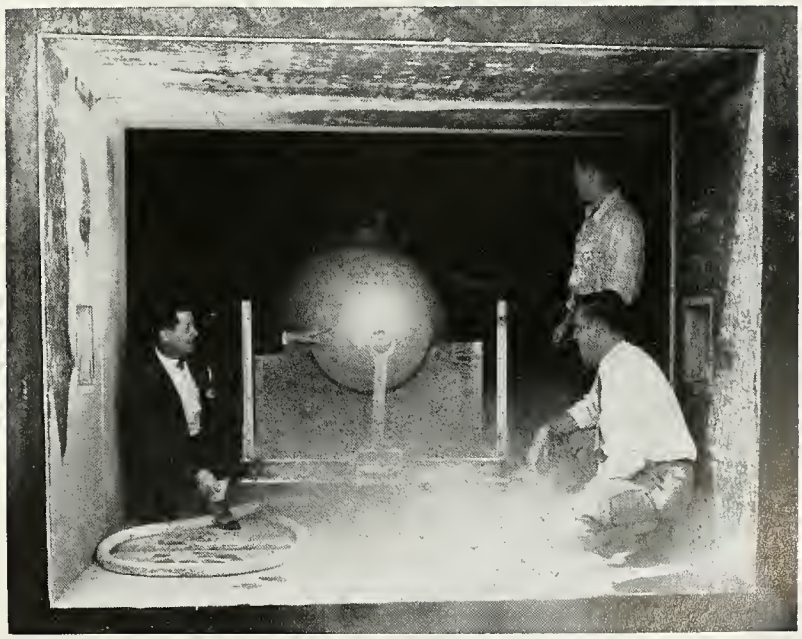
Both types of tanks were designed by Ryan engineers. Production of the B-47 tanks has just been completed after more than two years' work.

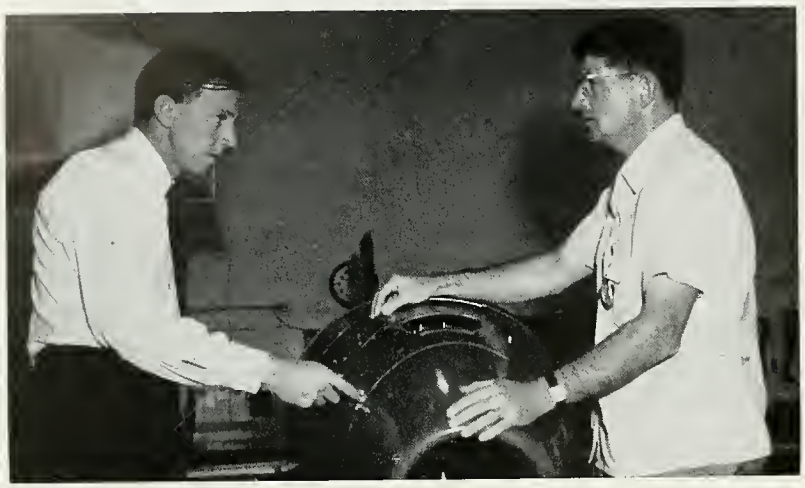
Rigorous testing of the KC-97G tanks has been conducted by Boeing in Seattle, and orders in excess of $2,000,000 have been received by Ryan in contracts which will provide at least two years' work.

Testing of the first models simulated severe conditions, considerably more extreme than anticipated. For example, a vertical vibration was induced at a speed of 2280 r.p.m. This was maintained for 25 hours, during which the tank was subjected to an estimated total of 3,000,000 vibrations.

In the fuel resistance evaluation, the tanks had to withstand temperatures of as low as minus 67 degrees under pressure of 10½ pounds, and as high as 158 degrees for periods ranging from 3 to 7 days.

W. M. Cattrell, left, of Ryan, and Charles Davis and Art Mathias of Boeing check fuel tank during extreme cold phase of test in "torture chamber."





Australian Expert Views Ryan Firebee

One of Australia's leading experts in the field of remote-controlled target planes, I. B. Fleming, recently visited the Holloman Air Development Center, Alamogordo, N. M., where he is pictured, left above, conferring with Mickey McDaniel, Ryan flight test supervisor on the Firebee project.

Fleming was shown the present state of the Firebee's development, of particular interest to him as head of the Government Aircraft Factory, Australian Department of Defense Production, because the Ryan plane parallels development of the Australian "Jindivik," a target drone of similar characteristics.

SIDE-BY-SIDE NAVION

(Continued from Page 25)

airplane being used in the Flight Training Evaluation program at Pensacola.

The Navy is evaluating the primary trainers of several companies entered in the competition in a unique method that is expected to provide the fairest comparison possible. The instructors will be checked out in each of the planes. The students assigned to them will be taken through the primary phase—at least four students for each of the planes. At conclusion of the training, an ideal cross-section of the opinions of the instructors will be available, as will the results of the actual training of the students in each plane. This is believed the first time the Navy has evaluated new type planes in actual training operations.

Ryan is admirably qualified in the training plane field. Before World War II, this 31-year old company produced the noted S-T metal-fuselaged monoplane sport-trainer. It became the forerunner of the Ryan PT-16 and PT-20, first low-wing trainers ever used for the initial instruction of military pilots. These were followed by the PT-21, NR-1 and PT-22 trainers, of which 1500 were produced for the Air Force, the Navy and allied countries. In addition, Ryan pioneered in production during World War II of the world's first combination propeller-jet fighter, the Fireball, for the Navy. After the war, more than 1200 commercial Navion and L-17 Army liaison aircraft were manufactured by Ryan.

Besides extensive training plane design and production know-how, Ryan has been able to call on its unparalleled experience in training 14,000 military pilots during World War II at three Air Force primary schools in California and Arizona.

Ryan hasn't dropped all its eggs in one basket in the development of the "side-by-side" trainer. In event the Navy deems it advisable to continue the tandem arrangement in its training program, an alternate tandem version of the "Model 72" has been proposed. The performance and overall dimensions will be essentially the same, but the weight will change slightly.

Meanwhile, the new idea is being given a complete test. And like all new ideas, it is bound to have an impact on future aviation concepts.

THE AIR POWER FUTURE

(Continued from Page 3)

and completes his contract for combat. Then electronic fire control systems come into action. Meanwhile, in many planes, an ever-watchful radar eye is alert to warn the pilot of any enemy who tries to attack from behind. Thus—to a gratifying, yet limited extent—we are solving the "space and time" problem of the supersonic fighter pilot.

This problem is basic in the air defense of our nation. Protection of our continent from air attack through the sea approaches is another of the Navy's important operational responsibilities of which I spoke earlier. It involves detection of enemy attackers sufficiently far from our shores to allow shore-based interceptors enough time to climb to combat.

This same problem of detection is inherent in our task of antisubmarine warfare. Aircraft are essential to this task because of the vast ocean areas that must be searched and patrolled. In applying the principle of economy of forces we are able to combine our early warning for air defense without barrier patrols against submarine attack. Successful performance of these missions is possible through our advances in electronics. Simultaneously with the air search, we are able to detect schnorkelling submarines. Once detected, their underwater path can be tracked by other aircraft and a lethal blow delivered. Recent developments in both helicopters and lighter-than-air craft have helped solve the problem of tracking and killing submarines.

As technology has provided us with improved weapons systems, we have been forced to rely more and more upon complex, intricate equipments. Without assistance in controlling the operation of these devices, a human pilot would be hamstrung. Here the science of electronic controls has made a tremendous contribution. Even the pilot's jet engine would not operate properly without electronic controls.

Although the electronic engineers have done a magnificent job in helping us to solve our problems, we still have not licked one problem—where to put their little "black boxes." As electronic equipment and electronic controls come into ever wider use in aircraft, we must constantly do battle to make them simpler, make them smaller, and at the same time keep them within the capability of the technician and mechanics we have to maintain them.

(Continued on Next Page)

We are, of course, making much greater use of transistors and magnetic amplifiers to do the work of vacuum tubes. Not only are they a fraction of the size of a vacuum tube, but they are more rugged (and have a longer life)—important considerations in combat. Again, many of the systems we are trying to crowd into our aircraft have circuits in common. By combining these common circuits we are able to effect economies in weight and size. It is a constant battle, but we shall win it.

In the major technological fields of aerodynamics, propulsion, and electronics, I have described the recent contributions of each to naval forces at sea—the Navy's sea/air team. The striking power of today's Navy is many times that which we found so valuable in World War II.

With aircraft presently coming off the production lines, operating from our modernized carriers as well as from our shore bases, the United States will have a naval weapons system with the highest mobility, entirely fit for its assigned mission.

As our combat pilots have returned to tell us their weapons requirements we have presented our problems to the aircraft industry. Through industry's aggressive efforts to supply the finest weapons in a minimum time and at reasonable cost, engineers have made immediate use of technological advances. Production has been expedited to the end that the fleet has received a flow of constantly improving weapons.

This member of your National Defense team has profited measurably from the present technological revolution, and the future prospects for naval air power are bright.

Westinghouse New Turbojet Engine Incorporates Ryan Afterburners

Announcement by the Navy and Westinghouse Electric Corporation, of Philadelphia, Pa., that Westinghouse has developed and placed in production a new high-power, low weight turbojet aircraft engine known as the J46 makes it possible to reveal one of Ryan's many new projects.

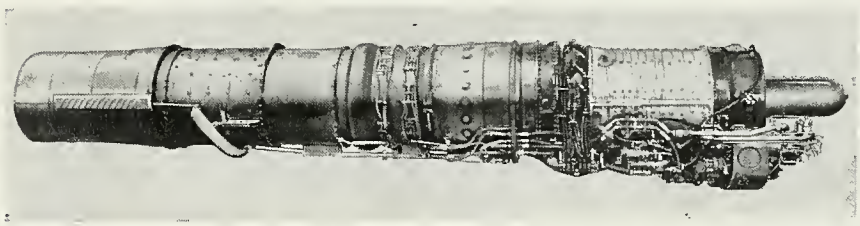
For some time, Ryan has been producing the complex afterburner to provide the mighty J46 an extra "kick." Production has been accelerating, but details of the project remain secret.

The J46 engine will first be used in the new swept-wing, tail-less Chance Vought F7U-3 Cutlass, one of the Navy's latest high speed carrier-based fighters. Earlier versions of the Cutlass used two Westinghouse J34 engines.

Westinghouse has announced that it will discontinue further development work on advanced models of the J40 engine in order to concentrate all its energies and resources on perfecting the J46. Meanwhile, production of the current model J40 will continue at Westinghouse's huge jet plant in Kansas City, Mo.

The J46 is an outgrowth of the J34, and has just successfully completed the Defense Department's grueling 150-hour qualification test, thus meeting an eligibility requirement for quantity production. The test was equivalent to more than 75,000 miles of actual flight, or three times around the world at the equator.

The J46 is about 16½ feet long and less than three feet in diameter. It is of the axial flow or straight-through design, which has become the standard of the industry. It weighs approximately 2,000 pounds. The Kansas City plant, believed the largest of its kind in the world, will produce the J46.



Ryan is devoting an increasing proportion of space in its jet engine parts building to work on the J46 afterburner. For more than a year, preliminary tasks were performed in the experimental department. Recently, the entire job was shifted to the production area. Ryan is currently working on approximately $2,500,000 in orders for these afterburners, with a considerable number of units already delivered.

20,000 JET ENGINES

(Continued from Page 13)

resided in the engines of the aircraft, naval vessels, trucks, tanks and other vehicles used to overwhelm the enemy.

With the advent of the jet engine, efforts to concentrate power into smaller packages were materially augmented. This engine develops power at one-half the weight of the best aircraft piston-type engines, which were already down to the amazing ratio of less than one-pound-per-horsepower.

The first jet engine built in America was produced by the General Electric Company in 1941. Undoubtedly, they were commissioned in this work because of their pioneering achievements in the development of the turbosupercharger, which incorporates components of similar nature.

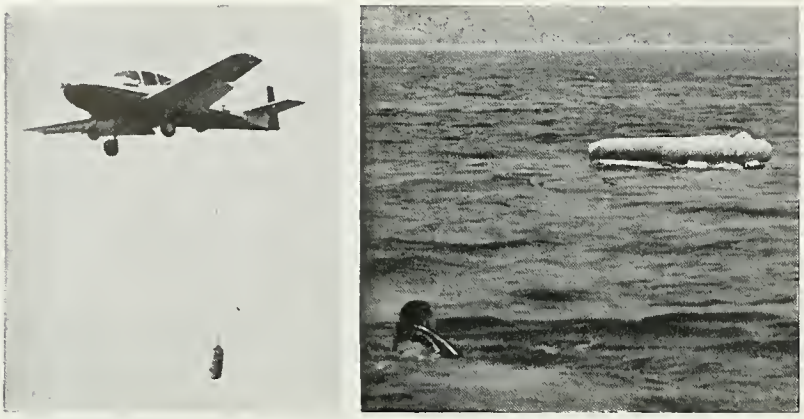
Recently, the General Electric Company announced the completion of 20,000 J-47 jet engines built in their Evendale and Lynn plants. This is 5,000 more engines than the total number of jet airplanes which have been built in the United States.

Ryan has contributed a vast number of the high temperature, sheet metal components which have gone into these power plants. These include high precision aft frames, fiery combustion chambers and transition liners, high strength exhaust cones and tail-pipes and thundering afterburners.

Since 1948, J-47's have logged more than one million flight hours in the F-86's, FJ-2's and B-45's built by North American, Boeing B-47's and Convair B-36's. This remarkable power plant has sped the F-86 to several world's records and been an important factor in the combat superiority which the F-86 has attained over the Russian Mig in Korea.

Rated at 5200 pounds of thrust, the power which these engines develop depends upon their speed in flight. At 600 miles an hour a J-47 develops power equivalent to about 8,000 horsepower. This is enough to zoom a 3,000-pound elevator up the shaft of the Empire State building faster than the speed of sound, or to drive 55 heavy trucks or buses down the highway.

Lined up in one continuous array, end to end, the 20,000 J-47's which General Electric has built would stretch out 45 miles. If the entire world's population were enslaved to operate one mighty machine, their combined muscular power would be approximately equal to the potential output of these engines.



Navion Used to Protect Pilots

A Ryan Navion is used by Douglas Aircraft Company in its air-sea rescue program to protect test pilots who might be forced to land at sea. Virtually all aircraft testing by Douglas pilots is over the ocean, away from congested municipal area. The Navion has been outfitted with a life raft that is dropped from its fuselage attachment like a bomb over a target. The raft is released by a handle inside the cockpit and unfolds and inflates as it drops into the ocean.

THE JET TRANSPORT

(Continued from Page 10)

Meanwhile, the company could not afford to wait during that 5-year period from 1946 through 1951 before getting into jet engine production. The transition from piston to jet production had to be undertaken as quickly as possible, for there was no question in our minds at the time that the jet engine was going to dominate the future of aviation.

It was for that reason that a group of us went to England in the summer of 1947 to obtain the blueprints and specifications for the Rolls Royce Nene turbojet engine, which was to be built under license at East Hartford for the U. S. Navy.

The first American-built J-42, rated at 5,000 pounds static thrust dry and 5,750 pounds using water injection, was running in East Hartford seven months after our trip to Derby, England. The first production Turbo-Wasp was turned out 16 months after specifications were obtained from abroad. This Connecticut produced Turbo Jet has served with the Grumman Panther in the U. S. Navy for the last four years. It powered the first Navy plane to destroy a Russian-built Mig in the Korean conflict. A more powerful engine, the J-48 Turbo-Wasp, is the direct successor of the first centrifugal jet. The first J-48's were rated at 6,250 pounds of thrust dry. Later versions have greatly increased power ratings. Almost all of the development work, both the initial and the advanced, was done on the J-48 in East Hartford.

Since the fall of 1949, this current production engine has been serving with the fleet. The Air Force also has this engine with our afterburner in its Lockheed F-94C Starfire interceptor.

Meanwhile, quantity production has been channelled toward our new, big axial-flow jet engine and away from the centrifugal-flow engine. The new engine, the J-57, is one of those which was started about six years ago. It is the present result of our intensive cultivation of the jet in East Hartford. This engine has no British antecedents, it is a Connecticut engine, born and bred. We believe that it will reflect credit on the industrial achievements of the State of Connecticut and our company. For security reasons, I am unable to give you the specific power rating of this axial-flow jet, but I can assure you that it is a very powerful turbojet engine, and, just as important, it has exceptional fuel economy. The Air Force's opinion of this engine is expressed by the fact that the engine has been selected to power the eight-engined Boeing B-52, the first big intercontinental jet bomber to be ordered into production. The engine is also slated for several advanced fighter planes. The engines are flying now in the Boeing B-52 Stratofortresses. They are also flying in Convair's B-60, eight-engined swept-winged jet development of the B-36. The first J-57 engine ran on a groundtest stand on June 27, 1949, in East Hartford. The engine first flew in our Boeing B-50 flying test-bed plane on March 8, 1951.

A substantial number of flight hours have already been logged on this engine. Its performance in these military aircraft has been most gratifying.

Now I would like to turn to the commercial side of aviation and speculate a little about the place which this Connecticut-built engine may have in the jet transport picture. First, let's take a look at the jet transport situation as it now stands. Any discussion in this field must begin with the British deHavilland jet passenger liner, the Comet, powered by four turbojet engines. The British have done an excellent job in the development of this jet airliner, but we doubt very much that in the long run England will be able to invade to any great extent the American flag airlines—domestic and international—with the present Comet, or any of its descendants.

The reasons for this are not readily seen on the surface. After all, we cannot ignore the fact that the British do have the Comet in operation now on a scheduled run and are gaining much valuable operational experience. This would appear to give our friends overseas a great lead in the race to supply the world market for jet airliners. But the British lead is less substantial that it appears. The Comet 1, which is the only British pure jet transport in operation, is unanimously considered in this country to have too short a range and carry too few passengers to be of interest to airline operators here. The Comet 1 cannot earn its pay on the air routes of this country.

True, the British are working on a larger version of the Comet, which will have greater load-carrying capacity and longer range, but several of our American airframe manufacturers are working on their versions of a big and an efficient jet airliner.

It is worthwhile to note here that the American manufacturers have set their sights from the first on a jet airliner large enough to fit profitably into the American concept of airline operation. Actual work on jet airliners of this size had to be timed to coincide with the emergence of an engine powerful enough to make these designs possible.

As for experience with four-engined jet aircraft, this country has been gaining more experience with multi-jet aircraft than any other nation simply because it has more multi-engined jets in operation than any other country of which we have knowledge.

The United States has been in full

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production on the six-engined Boeing B-47 medium jet bomber for almost two years. More than one of these bombers is being produced a day. In contrast, the British have only flown a few prototype four engined military turbojets and their total Comet production is very small.

Airline people in this country are in agreement with the American economic principle that the best way to get more customers is to give the public a substantially better product at the same or even a lower price. The airlines cannot expand their market for air travel by increasing their ticket prices. They have increased the use of air travel by tremendous bounds within the last few years by bringing prices down and increasing service.

So, when the realistic airline men in this country think of jet transports, they equate additional speed against payloads and operating expenses. A logical yardstick with which to measure desired jet airliner performance would be to take one of the present piston-engined transports which has proved efficient and profitable in operation. The Douglas DC-6 or the Lockheed Constellation would be the yardstick.

Replacement of the big fleets of DC-6s, Constellations and Boeing Stratocruisers will not be undertaken lightly by airline operators, and it is logical to expect that they will ask for a jet transport carrying at least as many passengers as economically as do the piston-engined aircraft on the airlines today. The Comet 1, which cannot fly 36 passengers from London to Gander, Newfoundland, falls far short of measuring up to these requirements.

To be of use both on the domestic and international runs, operators believe that a jet transport should be able to fly nonstop from New York to California carrying at least 70 passengers, at a cruising speed of more than 500 miles an hour. A turbojet transport with this range could serve on the transatlantic run with one stop at Gander, as well as on the transcontinental route. This is possible because, conveniently enough, the distance across the United States is about the same as the distance between London and Gander. The engine required for a turbojet transport of this type must be far more powerful and efficient than any which have so far propelled any commercial jet airliner. Speed, payload and range are not the only factors which dictate the use of such an engine. It is now expected that the existing runways at each end of the country will be used for jet flights. The construction of new and extremely costly airports solely for jet transports is believed unlikely. Therefore, engines must be powerful enough to lift the airliners from runways of present length with a good margin of safety on takeoff. One of the characteristics of jet flight is the increased length of takeoff needed over that required by propellor-driven aircraft.

The airlines and airframe manufacturers have been giving close study to all of these requirements—and many more—for the first big practical jet airliner, and I can say that the J-57 is prominently involved in their considerations.

I cannot say exactly how soon prototypes of any of the American manufacturers will be flying, but I don't think that they will be much behind the British Comet 3 or 4. In fact, they may not be behind at all. Even beyond that, the payoff will come on the production lines. The American builders hardly need prove their ability to put production in high gear.

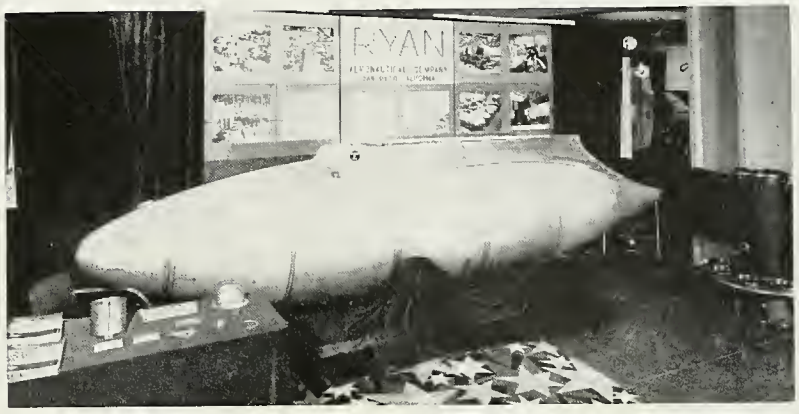
How soon will all of this come about? The process of building and testing a jet prototype, and then moving an economically sound aircraft into production and turning out enough of these transports for fleet operation is a long-range program. General use of jet airliners will not become common before 1960. Some experience with jet transports in this country with limited numbers of aircraft may be expected between 1956 and 1960. These dates, which seem to extend rather far in the future, mean that piston engined transports will be with us for many more years. It is likely that there will continue to be a place for the piston engine in both military and commercial operations where high speeds are not paramount.

World War II brought three big, powerful, competitors into the engine field with the two old-time companies, and gave the newcomers a head start in jets. What I have tried to do is give you an indication that Pratt & Whitney Aircraft is now in the thick of the jet engine fray.

This year approximately 50 per cent of our total horsepower deliveries will be in jet engines. In addition, one of our licensees, Ford, is busily engaged in also tooling up for production of our J-57 to supplement our own production of this jet.

I believe that through spirited competition among the engine and airframe designers in this country and abroad, America and the Western world will be served well. The jet has taken firm root in Connecticut and already it is a sturdy growth that has taken a prominent place in the sun.

(From "The Jet Grows in Connecticut," a speech by William P. Gwinn, made at New Britain, Conn.)



Display Puts Ryan In Limelight

The limelight was centered on Ryan during the recent National Aeronautic Meeting of the Society of Automotive Engineers in the Hotel Statler, Los Angeles, by this display, featuring one of the new external fuel tanks being built for the Boeing KC-97G aerial tanker. Also shown was a General Electric J-47 aft frame, at right, and titanium samples, on table.

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57 80

SAN DIEGO home of many aviation firsts PROGRESS CELEBRATES 50TH ANNIVERSARY OF POWERED FLIGHT SECURITY

31 YEARS OF RYAN PIONEERING MAKE U.S. PLANES FLY FASTER, FARTHER, LONGER

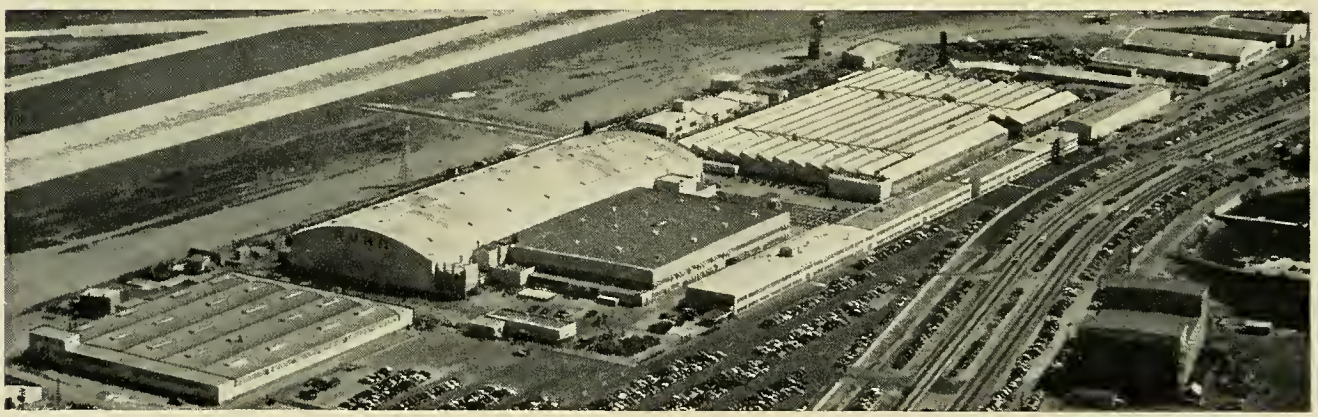
RYAN FLYING COMPANY, 1925

RYAN PLANT AND PT-20 MILITARY TRAINERS, 1941

Few people realize that today's great manufacturing facility at Ryan's modern San Diego factory grew from a 20 by 40-foot shop that housed Ryan in the early 1920's.

The almost incredible growth of the Ryan organization, and the important role it has played in helping to create a great new industry for 31 of the 50 years since the Wright Brothers first flew, exemplifies the success possible under America's system of free enterprise.

Consistently a leader in aeronautical progress, Ryan continues to offer the military services and its commercial customers products of both



FACTORY AND HOME OFFICE TODAY

demonstrated quality and performance. This ability plus Ryan's *seasoned management, vision, enthusiasm, ingenuity, perserverance,* and *thrift* have been responsible for the company's steady, healthy growth.

Today, Ryan's plant covers three-quarters of a million square feet of production area and 40 acres, and is staffed by more than 4,000 skilled aeronautical workers whose spirit and loyalty is extraordinary. It is this combination of skill, modern equipment and enthusiasm teamed with Ryan's versatile aviation experience that gives Ryan the edge in solving today's aircraft problems.

RYAN FIREBEE

Specialized, ingenious and *versatile,* Ryan is still contributing aviation "firsts" for it plans to continue to help build an even more "wonder-filled" air age in the years to come.

RYAN AERONAUTICAL COMPANY

Factory and Home Offices: Lindbergh Field, San Diego 12, California
Other Offices: Washington, D.C.; Dayton, Ohio; Seattle, Washington; New York City

RYAN

★ SPECIALIZED
★ INGENIOUS
★ VERSATILE

Advanced-type Aircraft and Components
Jet and Rocket Engines and Components
Exhaust Systems for Aircraft
Electronics Equipment
Ceramics for "Hot Parts"
Weapons Systems Design and Management
Aircraft and Power Plant Research
Metallurgical Engineering
Thin-Wall Ducting
Firebee Pilotless Jet Planes

Pioneers in Each ★ Leaders in All

Ryan REPORTER

VOL. 15, NO. 1

CERAMICS RESEARCH

Flame-spraying is new technique used by Ryan Ceramicist Al Pechman to fuse Nickel-Magnesia cermet which has fusing temperature above ordinary furnace. Cermet powder is blown through the 5500°F. flames of Oxy-acetylene torch.

THROUGH continuing research, the Ryan development laboratory is gaining increased knowledge about high temperature ceramic coatings. During the past four years, these thin refractory coatings —one thousandth of an inch thick—have been successfully applied to thousands of Ryan components for jet, piston and rocket engines. As the largest producer of such components, Ryan has amassed a wealth of experience in this specialized field.

Recently, the laboratory has accomplished several techniques such as flame-spraying refractory materials, ceramic coating large, thin-walled jet structures and welding through ceramic coatings.

Still in the research phase, flame-spraying is a spectacular operation in which powdered refractories can be momentarily liquified and sprayed on metal surfaces. For this experimental work, Ryan uses a spray gun which is designed for metal spray-welding purposes. Laboratory technicians have converted it to the application of cermets—or combination metal-ceramic powders.

Ryan has successfully flame-sprayed the promising cermet, nickel-magnesia, as a coating on stainless steel, inconel and other high temperature alloys. This cermet is made from nickel and magnesium oxide which have been combined, sintered and ground to powder. It has demonstrated its capacity as a coating to withstand temperatures up to 3500°F. for limited periods.

With a very high fusing temperature, nickel-magnesia cannot be applied to metal structures by ordinary furnace fusing methods. Ordinary furnaces will not provide temperatures above 2100°F. Especially insulated furnaces are expensive and difficult to design and operate for handling sizable parts. Another drawback is that jet engine alloys cannot stand the necessary fusing temperatures without losing strength and suffering other undesirable physical changes.

Flame-spraying circumvents these obstacles. The technique heats the cermet to the fusing point without bringing the base metal, to which it is applied, close to dangerously high temperatures. It avoids the use of expensive furnace equipment.

In the research work, the nickel-magnesia powder is placed in a container attached to the flame-spraying gun. Nitrogen gas forces the powder through a tube and into the hot torch nozzle. Oxygen and acetylene are also piped to this nozzle where they burn with a temperature of 5500°F. As the cermet flows through the hot flames it liquifies and is sprayed on the metal surface, like a fiery paint. Leaving the flame area and impinging upon the cooler metal, the cermet cools, solidifies and adheres in a refractory coating which can be applied to prescribed thickness. The base metal is not heated to temperatures which could cause warping or buckling.

The flame-spraying gun is light and dependable. Four valves control the flows of oxygen, acetylene, cermet powder and

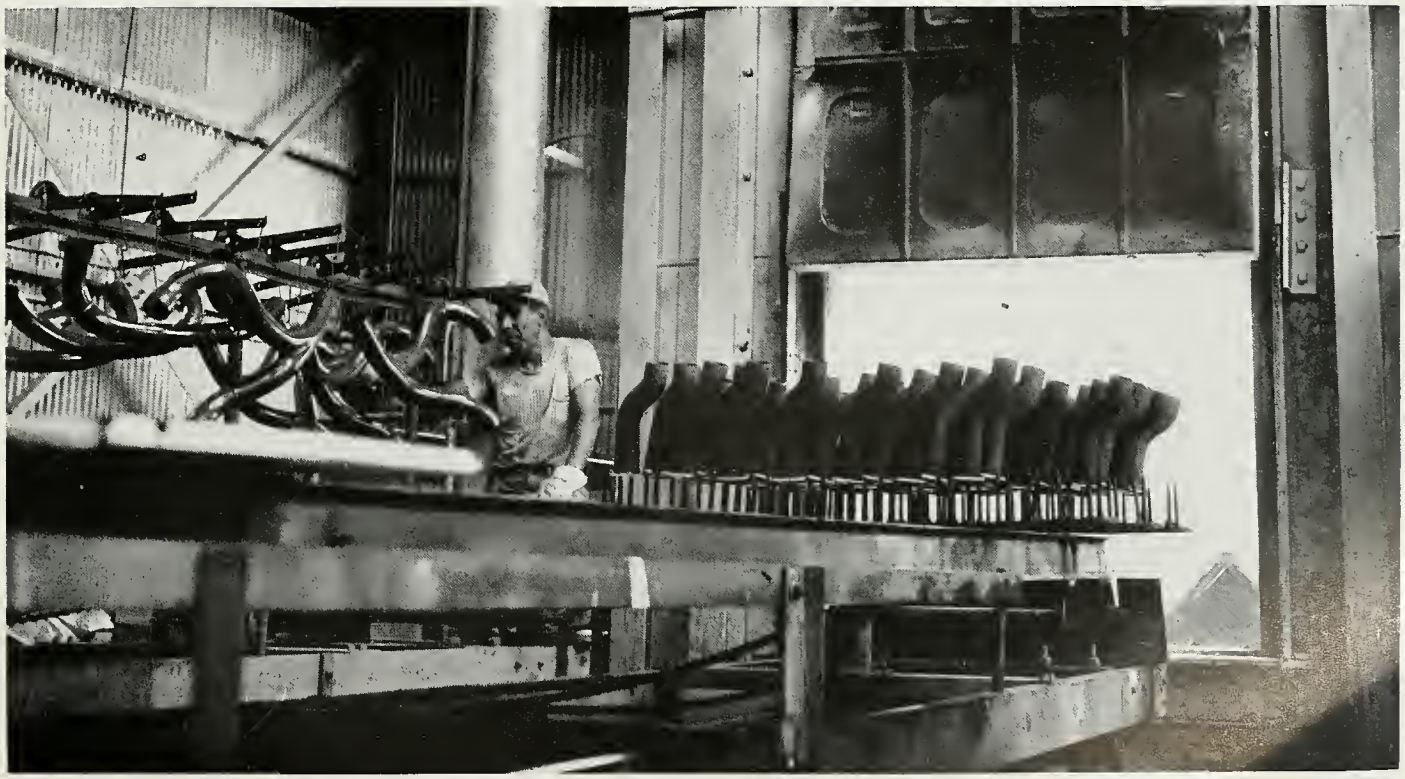
(Continued on Page 2)

Seething, short-life rocket parts, handling 5000°F. heat, are top prospects for cermets.

To ceramic coat large, thin-walled, corrugated structures, Ryan-Cameo have developed special cleaning, spraying and furnace-fusing methods.

A thousandth-of-an-inch fire-wall for "fire-engines"

Ready for a blazing bath of fire, Ryan-built exhaust systems for aircraft are loaded into Cameo's modern V-type fusing furnace.



Temperatures hit 3500° F. in Ryan-built G-E afterburners which burn fuel faster than jet engines. Cermets may extend their life.

Bursting out at 1200 miles per hour, the uncaged gases roar from the jet engines of a Douglas F3D-2 Skyknight. "Hot parts" for jet engines have been successfully coated with high temperature ceramics by Ryan.

nitrogen. Care must be taken to obtain uniformity in coating thickness. Ryan has applied the coating in various thicknesses ranging from less than .001" to .020".

Flame-spraying cermets, as coatings, may open new vistas of usage for afterburner liners, rocket parts and other similar high temperature components. These parts are called upon to withstand terrific heat and high velocity impingement of corrosive gases but are not required to have high structural strengths. Their service life may be materially extended by successfully applied cermet coatings.

For use with high strength components, such as combustion chambers, transition liners and exhaust systems, cermet coatings may be the means for extending operating temperatures by as much as 150°F. Present ceramic coatings are limited to temperatures around 1800°F. Above 2000°F. cermets will probably not be used to coat these parts because the metals themselves will not retain suffici-

(Continued on Page 20)

FIREBEE-HIVE

From the ground and from the air, Firebees prove their versatility at Holloman

TIGERS in the desert? Not quite. But a sharp eye might catch the glint of tiger's teeth in the indigo skies over the U. S. Air Force's Holloman Air Development Center, located just a moment—by missile—from the shimmering dunes of the White Sands National Monument in New Mexico.

The "teeth" belong to the fire-engine-red fuselage of Ryan's new pilotless jet target drone, and are the "trademark" of a new phase of the Firebee program.

With the research and development phase of the Firebee program nearing completion, the Ryan target drone has entered the "proof of the pudding" stage. Known as "operational suitability test-

(Continued on Next Page)

RIGHT
Making final adjustments after hoisting Firebee to wing launch rack of B-26 are A/2c Murgo and A 2c Barr of the AFOTC.

FAR RIGHT
"Birds on the wing" are inspected prior to flying first air launch mission with two Ryan Firebees installed on the B-26.

ing" (OST), this new phase is now being conducted at Holloman by the Air Force Operational Test Center of the Air Proving Ground Command, Eglin AFB, Florida.

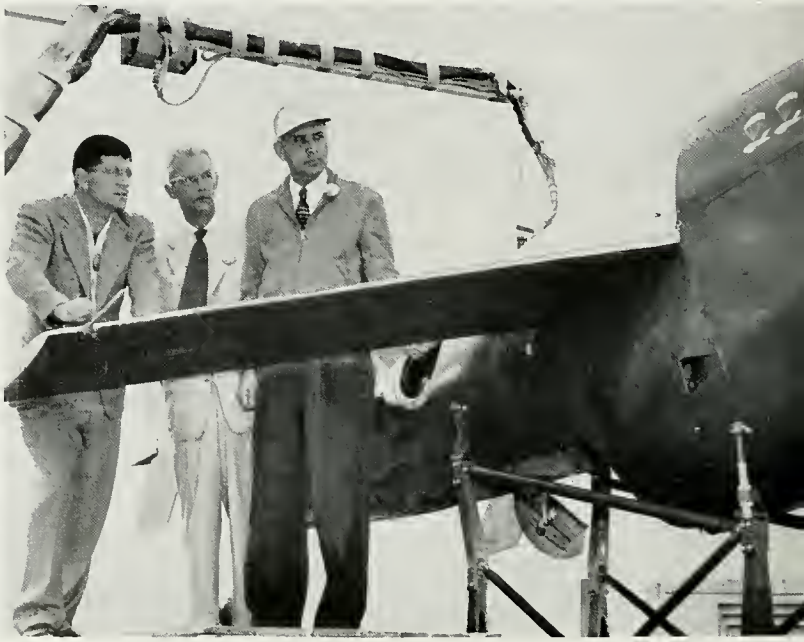
Activities of the AFOTC are centered in a small building literally bulging with colorfully decorated Firebees in all stages of assembly and disassembly. An imaginative paint brush has transformed Firebee air intakes into reasonable facsimiles of a tiger's mouth. Horizontal stripes on the tail assembly and the whimsical "I Go Pogo" emblazoned on the cowlings complete the "new look" peculiar to the OST drones, setting them apart from their research and development "brothers" located some distance away in the Air Force hangar assigned to the Ryan test group.

With both the Ryan test group and the Air Force Test Center Group located at Holloman, it is surprising that their activities appear completely unrelated in purpose and procedure. Headed by Mickey McDaniel, Ryan flight test supervisor, the Ryan group is concerned with the refinement of the Firebee design through continuous testing of new components, modifications and techniques. The Operational Test Center Group, on the other hand, is concerned with the actual capabilities and possible applications of the end product Firebee as an economical high-speed target drone.

Headed by Captain Glenn O. Kauf-

Col. Ralph H. Saltsman, Jr., 3205th Drone Group Commander, operates direct control box during a Firebee ground run.

M. M. McDaniel, Ryan flight test supervisor, briefs Ryan executives Bruce Smith and T. Claude Ryan on Firebee preparation at Holloman.



man, the Test Center Group is composed entirely of Air Force personnel—two officers and 15 enlisted men in all. Liaison between the two groups is maintained by a Ryan employee, William F. Berry, who serves in a technical advisory capacity to Captain Kaufman.

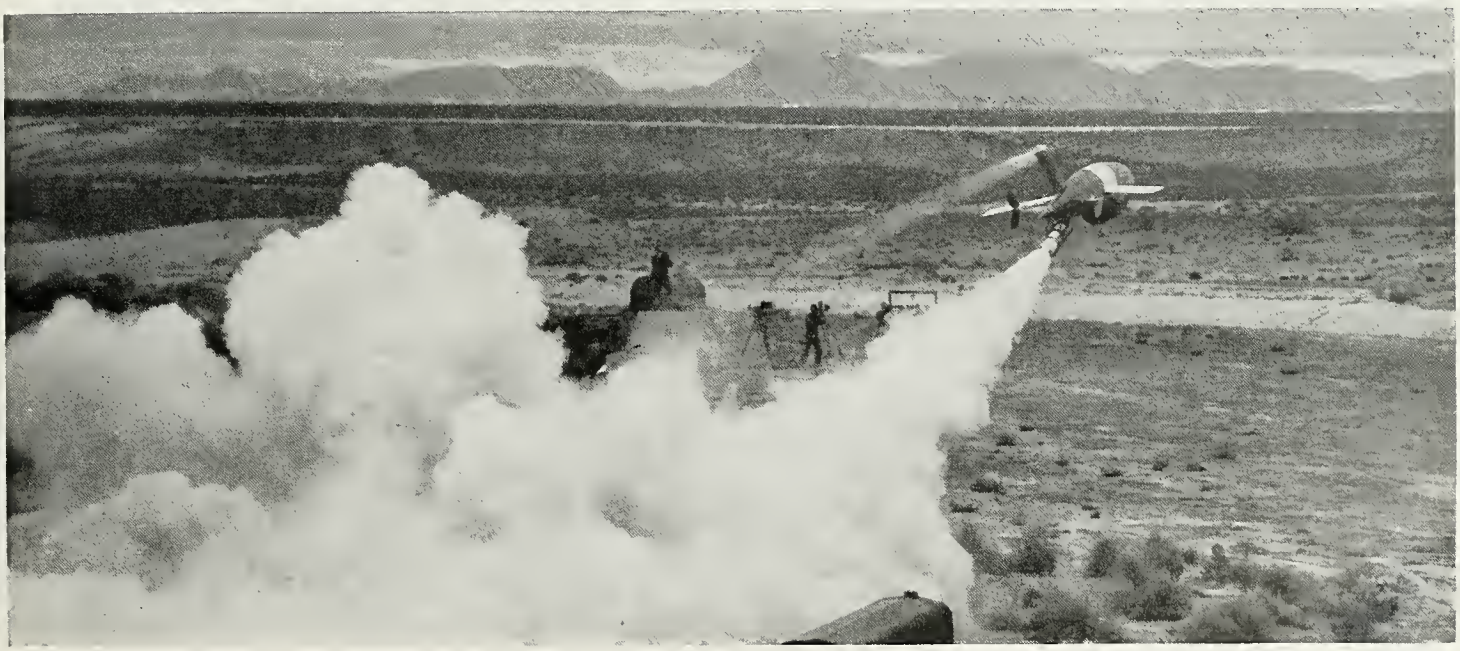
The Air Force Operational Test Center has delegated responsibility for operational suitability testing of the Firebee to the Air Proving Ground Command's 3205th Drone Group, commanded by Colonel Ralph H. Saltsman, Jr., at Eglin AFB, Florida. This responsibility was further delegated to the 3225th Drone Squadron, which has been attached to the Air Research and Development Command's Holloman Air Development Center for the past two years. Capt. Kaufman's section in turn was attached to the squadron at Holloman for the purpose of conducting the Firebee OST program.

Normally, operational suitability testing of an item such as the Ryan Firebee does not come about until the research and development work is completed and a final version becomes a standard production item. However, due to an urgent requirement for an economical high-speed target plane to supplement present drones, the final phases of research and development and the preliminary phases of operational suitability testing have been purposely overlapped.

For all practical purposes, Capt. Kauf-

(Continued on Page 24)

Leaving a billowing cloud of smoke and dust in its wake, a Firebee streaks into the air during recent ground launch tests conducted by Ryan test group at Holloman. Smoke originates from Rocket Assist Take Off (RATO) bottle suspended from aft section of fuselage.



SIDE-BY-SIDE vs. Tandem Trainers

by G. C. Danch*

FOR years the motoring public has joked about the back seat driver, yet somehow the plight of the professional back seat driver, the flight instructor, has never received its due recognition. His occupational handicap has been cause for concern, criticism and witticism but not until recently, cause for action.

The last few years, however, have seen notable strides made toward recognizing the problems of primary flight training instructors. There has been considerable re-examination of the requirements of good teaching and fast learning with a view toward providing a functional classroom (cockpit) tailored to the instructor's requirements and more closely aligned with the objectives of pilot training.

A most significant trend in this re-examination has been an increasing interest and awareness of the advantages offered by side-by-side trainers as compared to the classical tandem primary or basic trainer. The U. S. Air Force's T-37, the British Vampire and Avro trainers, and the Swedish Safir are some examples of this trend.

To an airframe manufacturer, like the Ryan Aeronautical Company, long a pioneer in the trainer field, the basic arguments on the question of side-by-side versus tandem are of great interest. The operation of military flight training schools and check-outs of hundreds of private pilots in the commercial Ryan Navion have afforded a unique background for the company to determine the advantages of side-by-side training. Paramount among these advantages is the ability of both student and instructor to make full use of the Audio-Visual aspects of learning—the two most important factors in the learning process.

With an improved audio-visual learning situation, better visibility and reduced maintenance problems and costs, the side-by-side trainer offers five unique advantages over the conventional tandem-type arrangement. It (1) accelerates student learning, (2) simplifies the instructor's job, (3) permits improved teaching and evaluation techniques, (4) reduces student apprehension and instructor tension and (5) increases safety.

First of all, the basic purpose of primary flight training is the acquisition of new skills by the student. In acquiring the new skills necessary to fly an airplane the student must:

Overcome any fear of his new environment;

Acquire the proper motor coordination skills necessary to initiate and maintain a desired attitude or perform a given maneuver;

Acquire the judgment necessary to perform safe solo flights;

Become familiar with procedures, routines and proper operation of the airplane and its controls and components.

Secondly, a major purpose of primary flight training is the early elimination, or weeding out of the program, of those students who are found to be unsatisfactory pilot material. The major problem involved in fulfilling this objective is one for the instructor. He must be able to thoroughly and accurately evaluate the student's ability, aptitude and progress during the course of the flight training.

Satisfactory attainment of these objectives of primary flight training is obviously dependent to a considerable degree upon the functional arrangement of the flying classroom. The ideal arrangement would provide the student with the maximum opportunity to learn, and the instructor with the arrangement best suited to the teaching tasks involved in transmitting his knowledge and skills to the student. In addition, the ideal training arrangement would not hamper the instructor's objective of constantly monitoring and evaluating his student's progress.

People who have studied the learning process agree that the majority of our knowledge is acquired through Audio-Visual means. Translated into the everyday language most applicable in the analysis of the trainer problem, Audio-Visual means that we learn primarily through what we see—observation; or what we hear—communication. To a considerable extent, the ability of both student and instructor to derive maximum benefits from Audio-Visual learning depends on the proximity of the student and his instructor.

As an example, observation by a student while the instructor demonstrates a vertical reverse can mean: 1) watching the motion of the airplane with respect to the horizon; 2) following through and watching the motions of the controls in the cockpit; 3) watching the instructor's physical actions during the maneuver. Under ideal circumstances, maximum use

(Continued on Page 8)

**Prior to joining the Ryan engineering department, Gabe Danch, now the company's Washington Representative, was Project Engineer on fighter aircraft with the U. S. Navy, Bureau of Aeronautics. He is an aeronautical engineer with a degree from the University of Michigan.*

Quotation on opposite page reproduced with the publisher's permission from the December, 1953, cover of Management Methods Magazine.

When something has been done a particular way for 15 or 20 years, it is a pretty good sign in these changing times, that it can be done a better way.

The excellent visibility and proximity of student and instructor is readily apparent through the bubble canopy of the "Model 72."

of visual learning occurs when the student can combine all three. It is apparent that this is practicable only in a side-by-side arrangement.

There are also varying degrees of audio learning as found in pilot training. For instance, an explanation or instruction over an inter-com is generally not as satisfactory as a directly spoken communication.

Voice inflections as a factor in understanding verbal communication must not be overlooked. As an example, the instruction "You've got it" with a different inflection becomes the question "You've got it?" This expression illustrates a serious situation not uncommon in flight training. A person's ability to grasp a meaning or more clearly understand the spoken word is considerably improved if he can observe the speaker. Facial expressions, motions of the hand or body and even a certain amount of lip reading contribute to our ability to understand what is said.

All in all, Audio-Visual learning can

(Continued on Page 20)

Navy check pilot Lt. (jg) Joseph Preston congratulates Marine Lt. T. F. Rockford, first student to solo in Ryan's Model 72.

Ryan executives T. Claude Ryan, right, president, and Bruce Smith, left, director of engineering, obtain reactions of Marine Capt. J. M. Babb, instructor, and Marine 1/Lt. W. R. Smith, student, following a flight in Ryan's new "Model 72" primary trainer.

Airpower Emphasized By Joint Chiefs Of Staff In "New Look"

Official U. S. Navy Photo

Admiral Arthur J. Radford, USN

From an address by Admiral Arthur Radford, Chairman of the Joint Chiefs of Staff, before the National Press Club of Washington, D.C. on December 14, 1953.

TODAY'S emphasis is actually pointed toward the creation, the maintenance, and the exploitation of modern airpower. Today, there is no argument among military planners as to the importance of airpower. Offensively, defensively, and in support of other forces, it is a primary requirement. Its strength continues to grow, both through increases in combat air units, and through better equipment.

Yet now, and for an indeterminate period in the future, under most circumstances, air forces must be complemented with other forces. Land forces, amphibious forces, anti-submarine warfare forces, and other well-rounded forces are necessary. Therefore, we aim to build up also the effectiveness of the Army, Navy and Marines with better equipment, new weapons, and a better planning of reserve components.

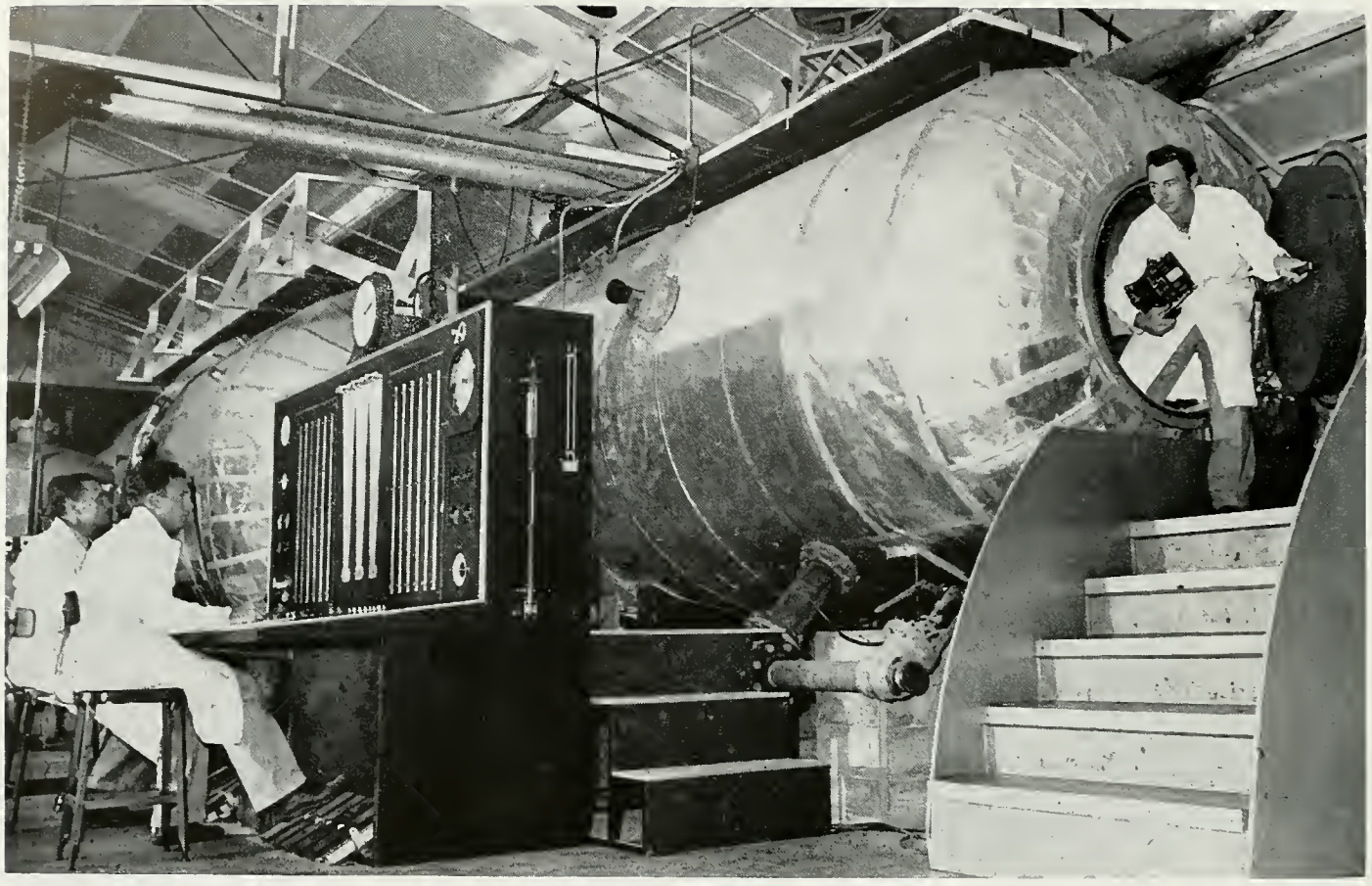
Today, atomic weapons have virtually achieved conventional status within our Armed Forces. Each military Service is capable of putting this weapon into military use. Therefore, each Service has a tremendous responsibility for living up to our expectations for a still greater and more powerful degree of combat readiness.

The Joint Chiefs of Staff have no preconceived ideas as to what our Armed Forces will look like a decade from now. The views and estimates we submitted last week are based upon what we see today as being in the best interests of the United States and the Free World. None of us can be certain of what will happen in the future. Improved guided missiles, atomic-powered ships and aircraft, an enlarged family of weapons, and new applications of electronics, all will have their effects and will be reflected in the evolution of our combat units.

At this time of the 50th Anniversary of Powered Flight, it would seem appropriate for me to amplify what I mean by national airpower. As I use the term, it includes the Air Force, Naval Aviation, Marine Corps Aviation, Army Aviation, and the tremendous aircraft industry and civil air transportation systems of the United States. You may not fully comprehend the true magnitude of today's United States national airpower; but I will state unequivocally that it is superior to that of any other nation. Furthermore, the United States has so developed certain segments of its airpower as to achieve a strategic air force and a naval carrier striking force which are without peer in this world.

The President of the United States, the Secretary of Defense, and the Joint Chiefs of Staff are of one mind on that matter: *this nation will maintain a national airpower superior to that of any other nation in the world.*

This supremacy in national airpower, when coupled with that of our Allies, and with our collective strength in other forces, should lead the people of the United States and the Free World to reflect with pride on the progress and the achievements of the last half century, and to look to the future with confidence and resolution.



Flight conditions up to 75,000 feet are simulated in this AiResearch Stratolab chamber to test heat transfer cooling equipment.

Cooling Electronic Equipm

How to get cooling and heating from the same fuel

by Doyle C. Wells, Ryan Electronics Engineer

Doyle Wells came to Ryan in 1950 after graduating from San Diego State College with a physics degree. Much of his work in electronics is concerned with the cooling needs in order that systems may be designed to function together. He prepared this article as a paper for a recent SAE technical meeting.

IN the past year, work on liquid cooling systems and associated components has been undertaken at the Ryan Aeronautical Company for the purpose of determining how they may be applied to subminiaturized electronic equipment, microwave power tubes, and electric motors and generators. In general, subminiaturized equipment with power densities as high as 2 watts per cubic inch can be cooled with liquid. Small liquid cooled motors of the a-c type can be run continuously at over 200 percent the normal power for their size when air cooled. One liquid-cooled motor produced a continuous output power of 35 watts while an air-cooled continuously operating motor produced 17 watts and was about 30% larger. A microwave transmitter tube with a dissipation of over 50 watts per square inch has been cooled with a liquid system. In this system, the liquid velocity was purposely kept low to avoid microphonic tube noise. A small centrifugal pump driven by a three-phase, 400 cycle motor drawing 30 va was

used to circulate the coolant through the tube and associated temperature regulation channels.

The liquid used in most cases was triethelene glycol and was chosen for its high specific heat, high density, low freezing point, and low vapor pressure which permits operation at 50,000 feet altitude without pressurization. This liquid has a high viscosity at low temperatures, necessitating a careful consideration of pump design in all respects. In general, pump clearances are made large, fewer guidance vanes are necessary, and high velocities are avoided. As a rule, pumps with 40 to 50 percent efficiency are possible with this viscous liquid if extreme care is taken in their design. As a rough rule of thumb, it takes about five watts of electrical energy at the pump input for every one hundred watts of heat to be removed by the cooling system. This figure may vary twofold depending on the specific requirement of a cooling system.

The cooling environment imposed on a piece of equipment by an aircraft of a few years ago was not far different than the environment of a ground or sea based vehicle. Today, in contrast, the cooling environment has changed drastically due to higher speed and altitudes.

Cooling in the past has been done by passing air over and through the equipments. This air was taken from the outside of the airplane through ram air intakes. The air in the intakes was sped up from zero to almost the aircraft speed and thus was compressed by virtue of its momentum change. The air temperature increased along with the pressure rise. In slow aircraft, this temperature rise was not troublesome although it had to be taken into account.

Since the temperature goes hand in hand with the pressure, one can see that the temperature of ram air will rise to intolerable values at around Mach one. Since the ram temperature is directly proportional to air density, the ram rise will be lower at high altitudes. This effect, however, is cancelled out in any heat exchange system because the heat transfer coefficient is also proportional to the air density.

Like a tornado in a teapot, this AiResearch midget turbine spins at 100,000 r.p.m. to provide frosty air for cooling subsonic aircraft such as the Lockheed F-80 Shooting Star.

The situation at Mach one and above, then can be summed up as follows: (1), any air taken from the outside will be too hot to use in its present condition of temperature (2), air inside the aircraft will also be too hot to use after steady

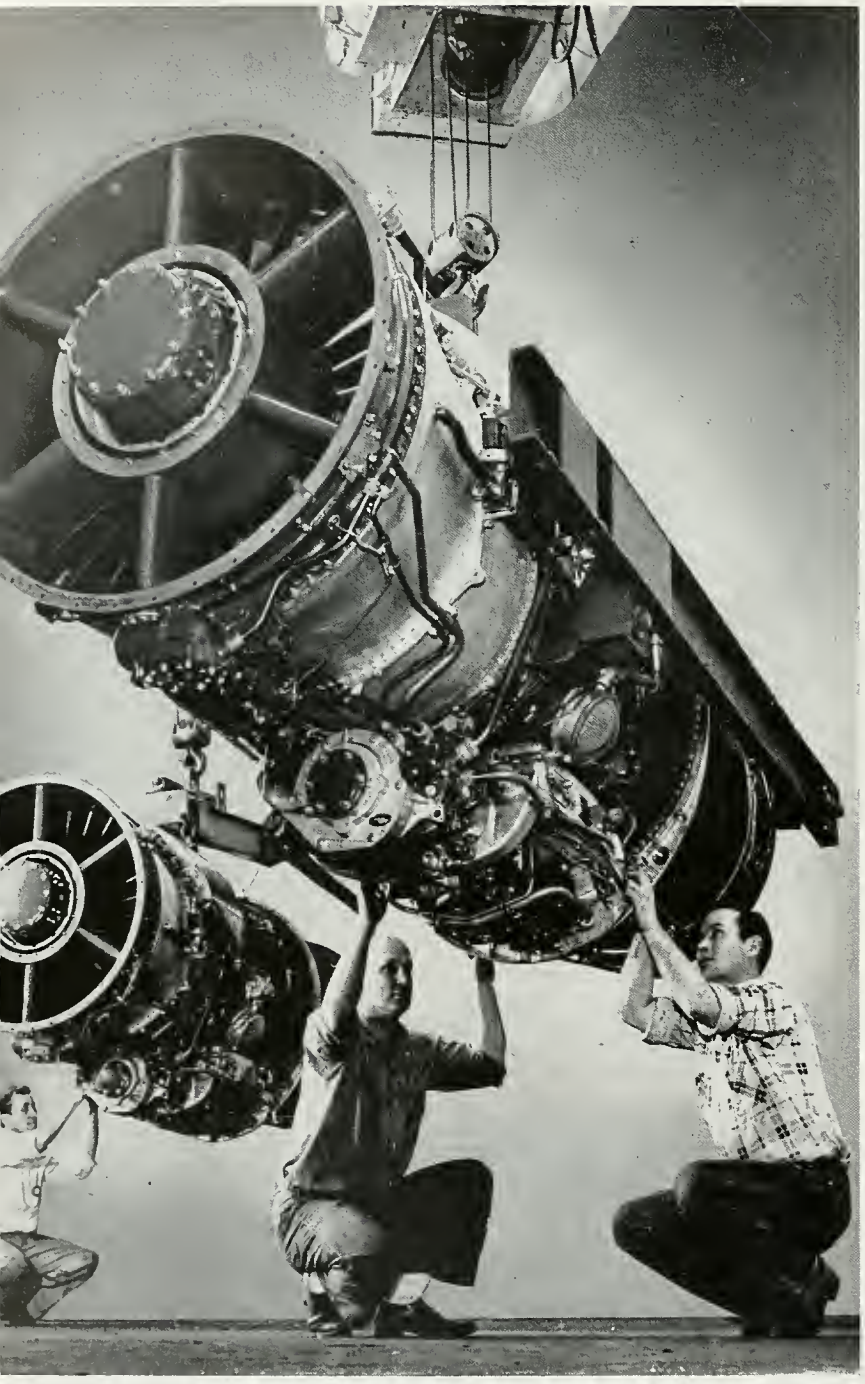
(Continued on Page 22)

nt in Supersonic Aircraft

Typical electronic equipment, adding heat to the aircraft, is this radar "eye" used in the Northrop P-61 night fighter.

Methods for cooling equipment must be independent of outside air in supersonic aircraft such as the North American F-100.

GIANT



No clue to their fierce power in flight is revealed by the hard geometry of these J-57 turbojets as they hang motionless in mid-air at the P & W plant.

NEWEST entry in the race for power is the recently revealed Pratt and Whitney Aircraft J-57 jet engine. First turbojet in aviation history to achieve a thrust rating in the 10,000 pound class, the powerful engine has a brilliant future mapped for it.

In the military field, engines are the key to air supremacy. The J-57 will play a dominant role in the potent, new weapons of the Air Force and Navy. The spectacular performance of the huge Boeing B-52 Stratofortress and supersonic North American F-100 Super Sabre are sparked by this marvel of packaged power. Soon, the Convair F-102 delta-wing interceptor, McDonnell F-101A Voodoo, Douglas F4D Skyray and Douglas A3D carrier-based bomber will flash across the skies under its fierce urging.

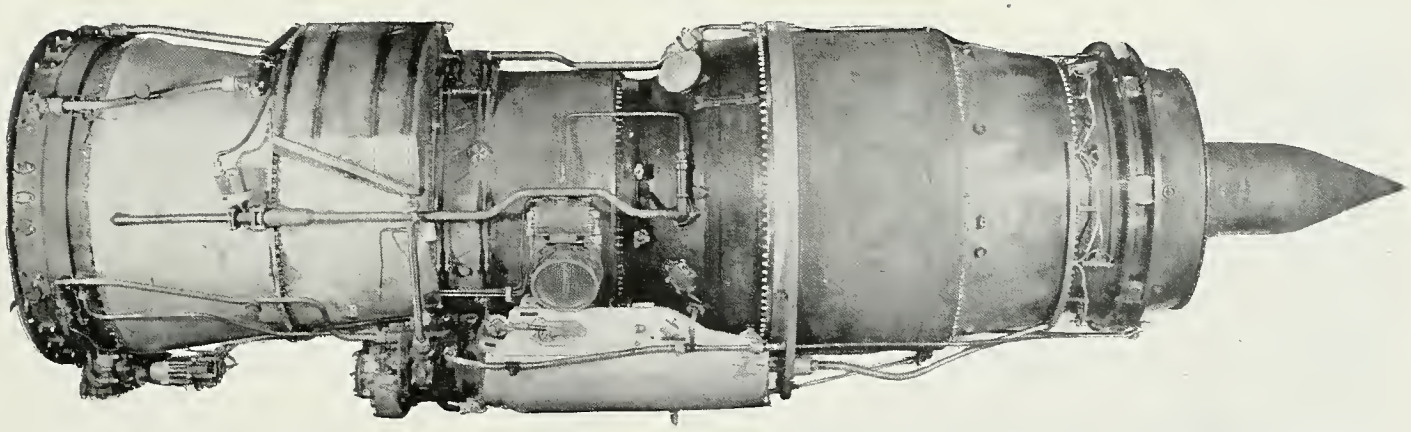
Because of its exceptionally low specific fuel consumption and rapid rate of acceleration, the J-57 is one military engine which also possesses commercial attributes. It is tentatively slated to power Boeing's 100-passenger jet transport—

First to achieve five-figure rating, Pratt & Whitney Aircraft's J-57 is most powerful turbojet in production

Three years ago, Ryan began building parts for the J-57 such as this experimental case weldment being tested under hydraulic pressure. Robert Chase (right) and P & W Rep observe the results.

JET

With eight J-57 jet engines podded below its fast, knife-like wings, the Boeing B-52 packs enough power to drive a battleship. Clean lines gives it fighter appearance.



Side view of J-57 shows precision-built sections from nose (left) to tail cone. Dual compressors give high compression ratio.

the Model 707. Since this military-civil transport will undoubtedly be the first American plane of its type to fly, the J-57 may likely become an important factor in the international competition for airline business.

Ryan is a major manufacturer of the "hot parts" for the J-57 and is producing these precision-made structures for both Pratt and Whitney Aircraft and their J-57 licensee—the Ford Motor Company. Ryan engineers have worked closely with Pratt and Whitney Aircraft since the early stages of the engine's development, building many of the experimental parts as long as three years ago.

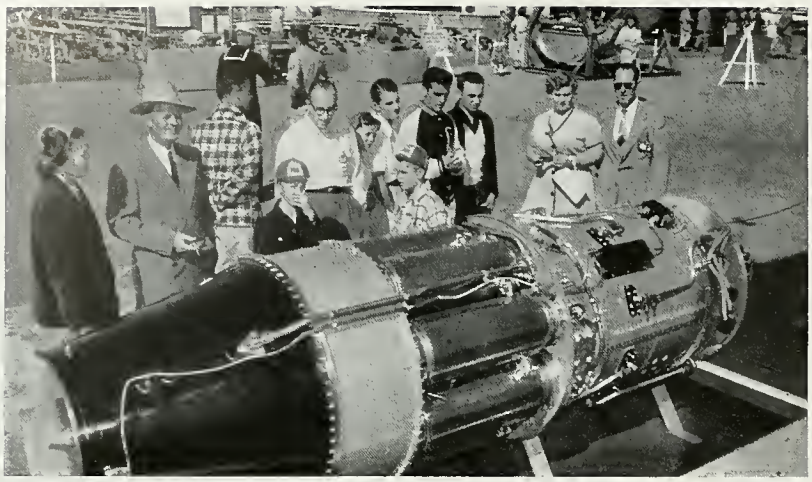
10,000 pounds of thrust is a frightening amount of power. Because jet engines are rated in terms of thrust, the significance of their tremendous power is often lost. In an airplane flying at the speed of sound (764 miles per hour under standard conditions) the J-57 will be developing a thrust equivalent to more than 20,000 horsepower. With its afterburner on, this gargantuan force would be boosted to 30,000 horsepower. This is more than enough to drive a 10,000 ton heavy cruiser.

To develop the J-57, Pratt and Whitney reached out far into the future. Six years ago, company officials decided to design and build a turbojet which would close the gap between the then more powerful British jets and American versions. They staked their resources on the bet that aircraft development would demand a 10,000 pound thrust engine by the time the J-57 was ready for production and that their creation would be solidly ahead of anything in the field at that time.

Only engineers and metallurgists can fully realize the extent of risk involved in this type of venture. They are charged with the solution of the complex design problems which must be dispatched with-

(Continued on Page 25)

First fighter to fly faster than the speed of sound in level flight, North American F-100 Super Sabre gets its sizzle from a J-57 tucked away in its gleaming fuselage.



Many of America's jet engines, including this Allisan praduct, were on display in huge outdaor area near the campany's cafeteria plaza.

The Navy's exhibit at Ryan's "Family Day" and open ho ground, used by Ryan for airborne electranics equipme

WORLD'S FIRST
MILITARY AIRCRAFT ENGINE
4 CYL. 28 H.P.
SAME ENGINE AS USED IN FIRST U.S. ARMY MILITARY PLANE DELIVERED TO THE SIGNAL CORPS.

World's first military aircraft engine was inspected by these twa Ryan families, Harold Wright, assistant supervisar, materiel contral, Mrs. Wright, and Ricky, David and Marsha; and right, Leonard Olson, Dept. 250 patternmaker, and Mrs. Olson.

THEY CAME, S

Ryan's first "Open House" in

TWENTY thousand persons swarmed over Ryan Aeron tory buildings recently in the first "Family Day" and tools in action, inspected some of the newest planes a Navy, received souvenirs and enjoyed refreshments in t warming sights was the children gaping with amazement or Mom operates in the plant. One of the highlights v awards for the best record among large San Diego indus

Ryan family groups at gas-fired furnace are "Chief" Walker, his wife and two sons, and Trudy Flenniken and two sons.

Thousands of stainless steel ash trays were given visitors who saw souvenirs stamped out from scrap metal on press.

One of Ryan's

:luded the Lockheed Neptune patrol bomber, in fore-
ring; Grumman Cougar fighter and Piasecki helicopter.

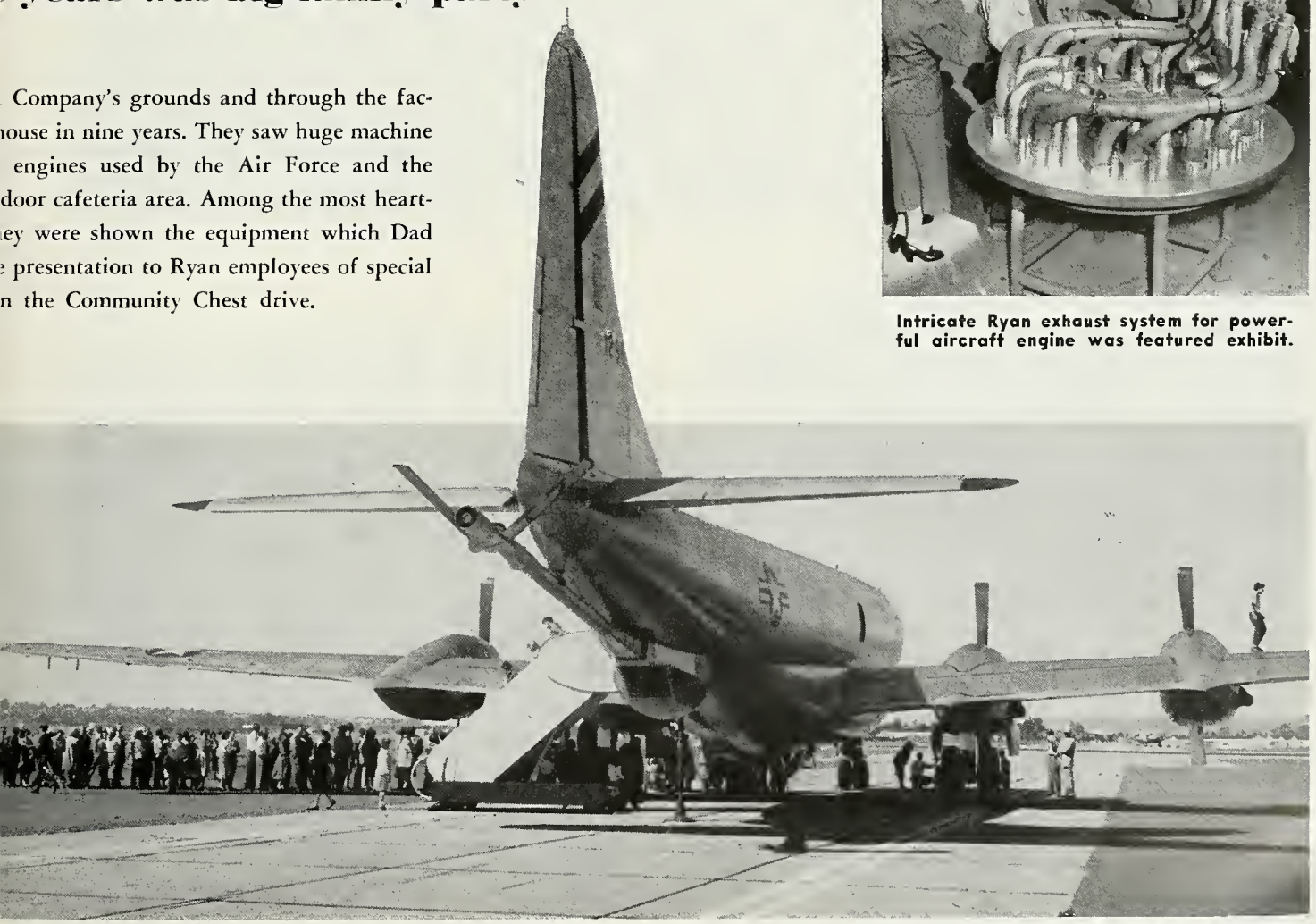
Crowds had an opportunity to see how Ryan exhaust systems are used in the Pratt & Whitney R-2800 engines of the Convair Liner 340 transport.

W and MARVELED

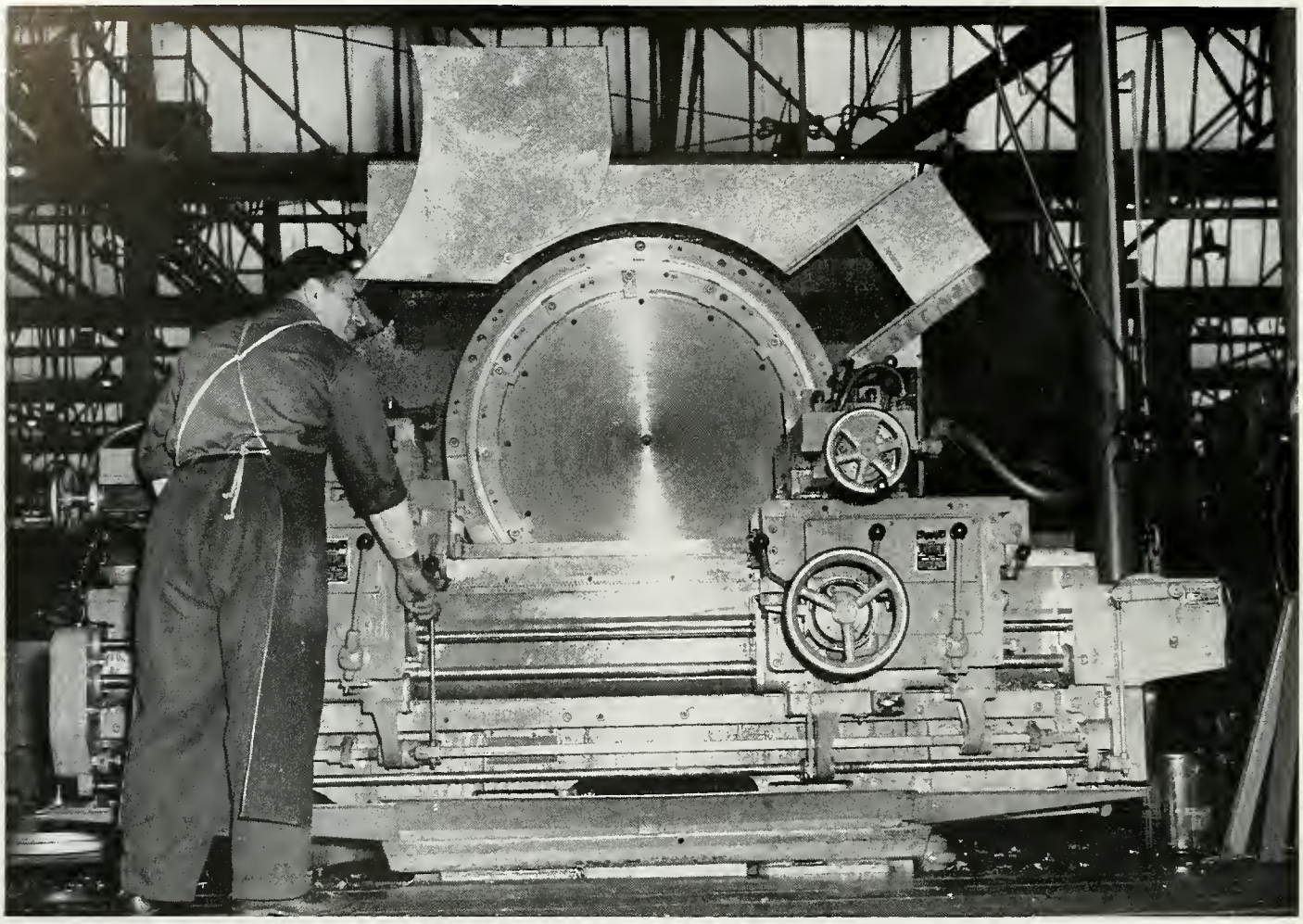
e years was big family party

Company's grounds and through the fac-
ouse in nine years. They saw huge machine
engines used by the Air Force and the
door cafeteria area. Among the most heart-
ey were shown the equipment which Dad
e presentation to Ryan employees of special
n the Community Chest drive.

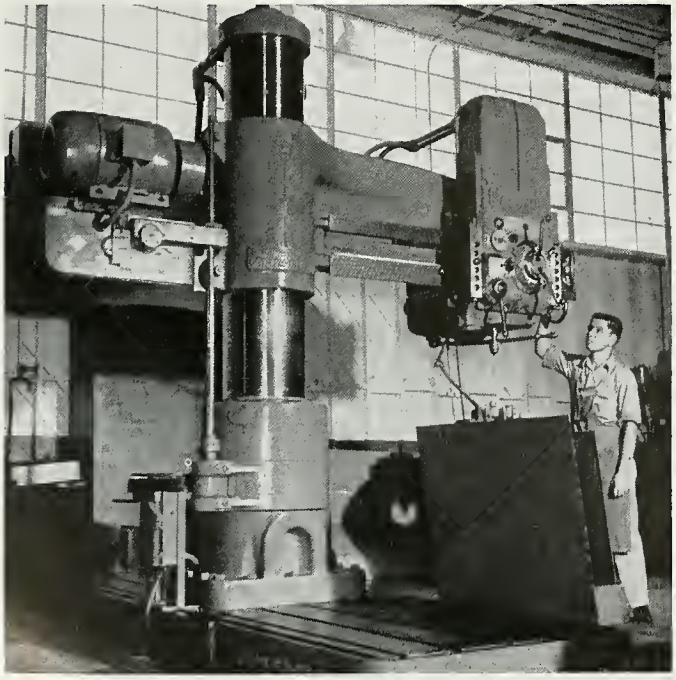
Intricate Ryan exhaust system for power-
ful aircraft engine was featured exhibit.



gest and most versatile planes in the Air Force, the Boeing KC-97 was viewed by the general public for the first time in San Diego at
Day" and open house. Thousands inspected the aircraft, for which Ryan builds the aft fuselage section, refueling pod and other parts.



Nick Sherrillo operates a new Lodge and Shipley T lathe which can machine large diameter parts with high precision and control.



Largest radial arm drill at Ryan is adjusted by James Smith to drill J-57 part. Machine can also do precision tapping.

JET AGE TOOLS

Powerful new machine tools with hair-splitting accuracy are used to build J-57 components

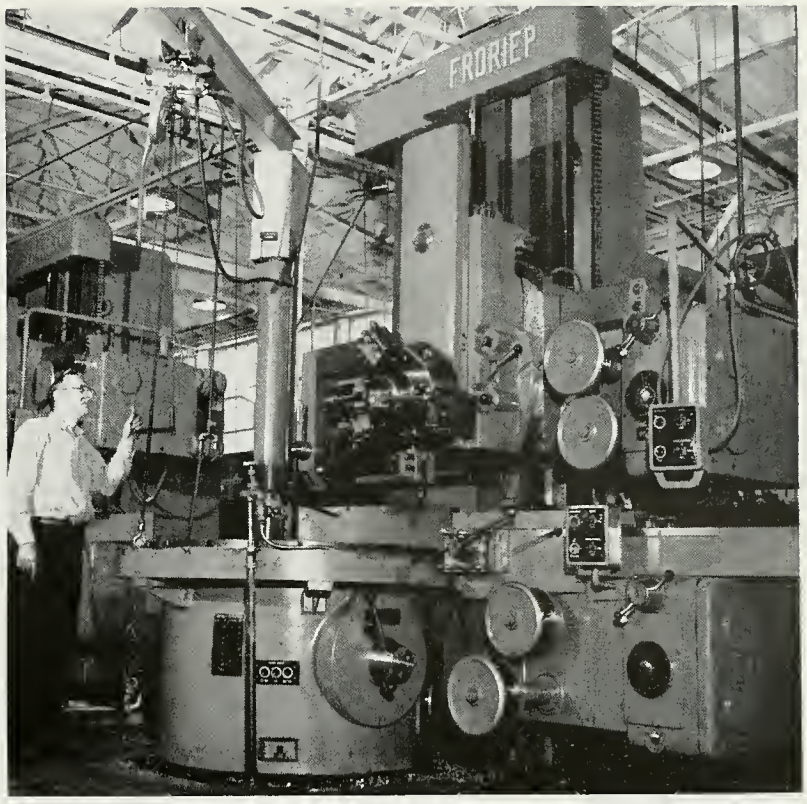
MACHINE tools look pretty much the same wherever they are used. There doesn't appear to be much difference between lathes, mills and drills used in aircraft plants, automobile factories or other production facilities. But there is a marked difference in the way in which they are used.

Higher accuracy is required to build a reciprocating engine for an airplane than for an automobile. As much difference again exists between the requirements for building the modern jet engine and the conventional aircraft power plant.

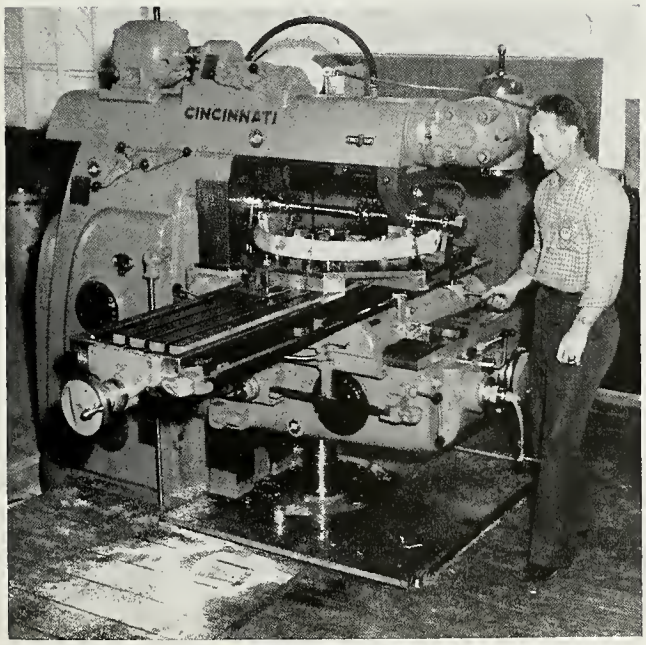
Spinning at 15,000 r.p.m., jet engine turbine blades weighing only a few ounces, exert a force of 25,000 times their own weight. At flight speeds, three tons of air a minute are accelerated up to 1300 miles an hour through a jet engine. Component wall temperatures often hit 1800° F. with flame temperatures soaring above 3500°F.

Structures designed and built to operate under these shattering conditions must be perfectly welded, machined and fitted together. Even tiny imperfections can have explosive results under supersonic speeds and withering heat. Consequently,

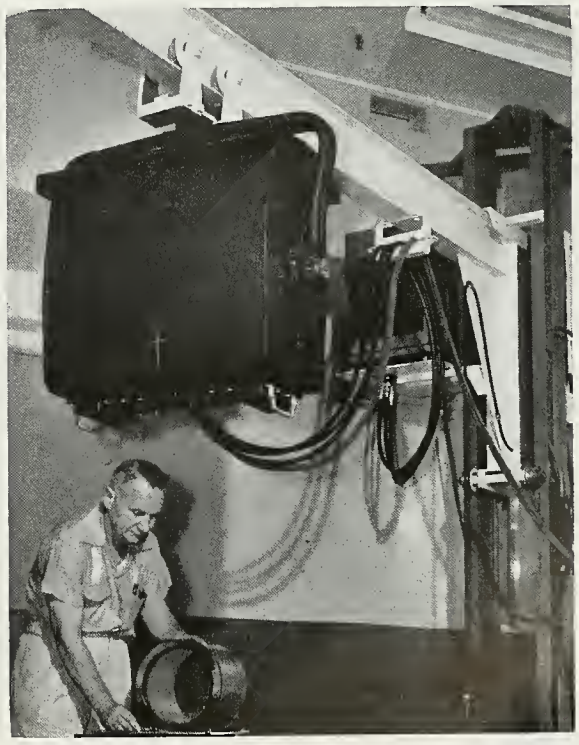
(Continued on Page 26)



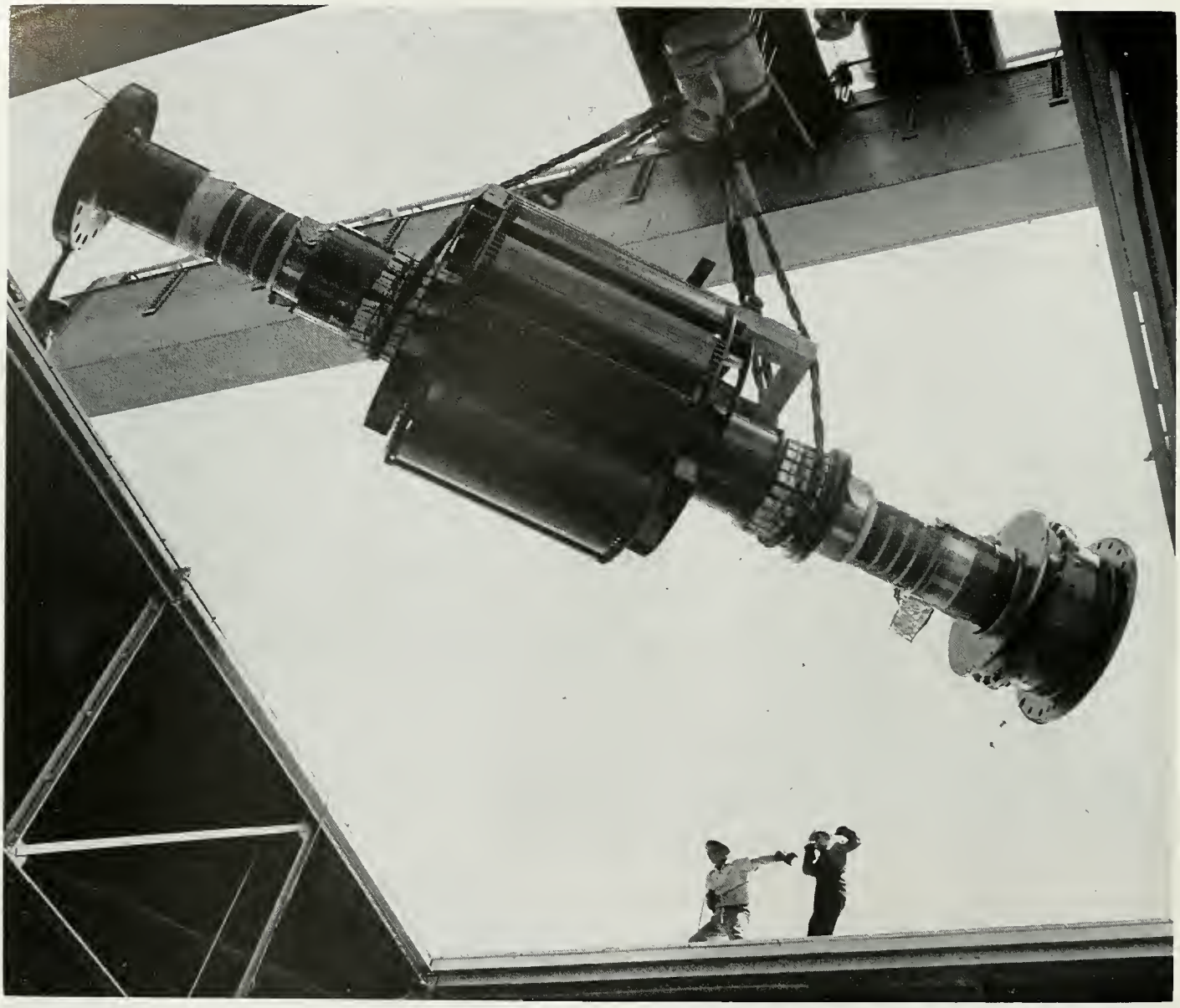
Mainstays of heavy duty machining at Ryan are 12 vertical turret lathes. William Williamson operates a German Frariep used to machine J-57 parts.



New Cincinnati machine, operated by James Bunch, can do horizontal and vertical milling at same time on separate parts. Miller is also calibrated to perform jig boring.



Most searching "eye" at Ryan is new 250,000 volt General Electric X-ray which can "see" through over four inches of steel. Irve Holtz shoots pictures.



Dwarfing workmen to Pygmies by contrast, the 122-ton rotor for a Westinghouse 83,000 horsepower motor is lowered through hatch.

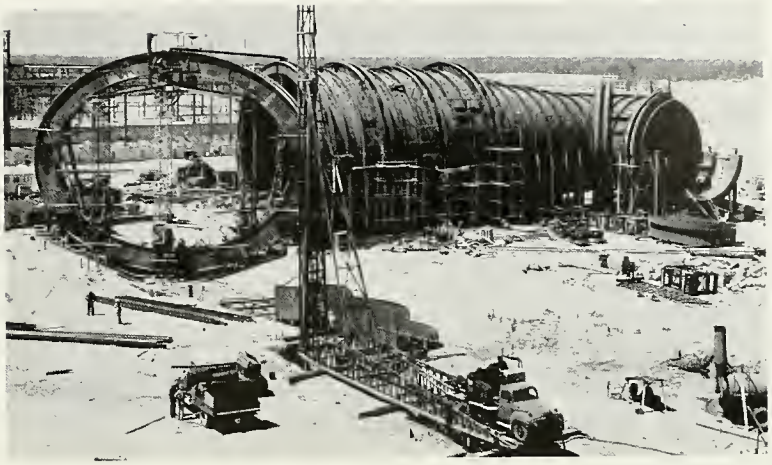
Mammoth Motors

Westinghouse powers a supersonic hurricane

MICHAEL FARADAY would gasp in astonishment at two tremendous electric motors which Westinghouse Electric Corporation is building. The world's most powerful, each of these huge electrical giants will develop 83,000 horsepower. Their combined power is equivalent to that generated by 40 railroad steam locomotives. They are being installed in the Air Force's new wind tunnel at Tullahoma, Tennessee.

It is difficult to believe that these motors are patterned after the tiny toys with which Faraday experimented when he developed the basic principles of the electric motor 130 years ago. Each machine stands 21½ feet high and weighs 225 tons. The stationary part of each motor, the stator, weighs 75 tons. The rotors, which will spin at 600 revolutions a minute within the stators, will weigh 122 tons each.

With two 25,000 horsepower Westinghouse wound-rotor induction motors, these record-breaking machines will form a 216,000 horsepower drive to power five huge air compressors. Compressed



One side of the 1126-foot transonic wind tunnel at Air Force's Arnold Engineering Center, where Westinghouse motors will be used. Supersonic tunnel will be added.

air from these units will feed the transonic and supersonic sections of the new wind tunnel. With the completion of this facility—the world's largest—full-size jet engines, guided missiles, fuselages and wing sections can be tested at speeds up to 2500 miles per hour.

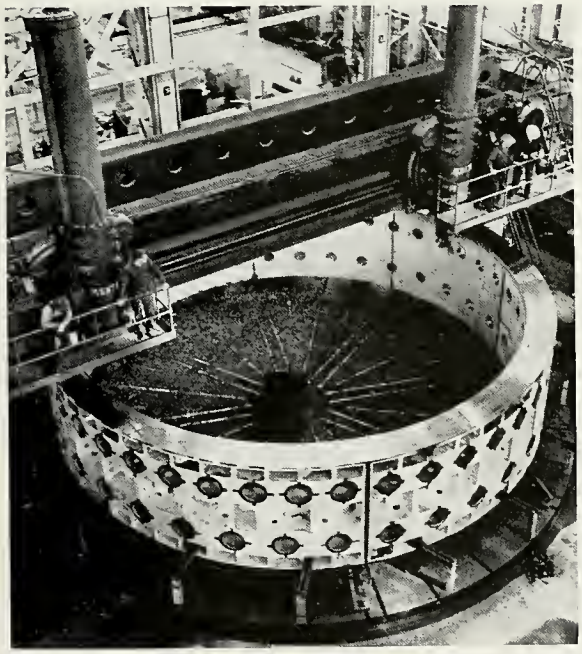
The transonic section of the tunnel, which is 1126 feet long and 55 feet in maximum diameter, will be completed in 1955. The 1600-foot long supersonic section is scheduled for readiness by 1957. Westinghouse is building the electric motors for this project in their East Pittsburgh plant.

The five mammoth compressors are also being fabricated by Westinghouse, in their Sunnyvale, California plant. Blades for these monstrous machines will measure two feet wide, six feet long and will weigh almost two-thirds of a ton each. They will be mounted on a spindle which is 18 feet in diameter.

The compressors and their 216,000 horsepower drive will comprise the world's largest rotating machine. Although this machine will have the highest stored energy of any rotating mass, it can be brought to a halt in about three minutes. This is accomplished by using its wound rotor motors as brakes and dissipating the energy in liquid rheostats.

During operation, the wind tunnels will require 100,000 gallons of cooling water per minute to reduce the air discharge temperature to about 600°F. Air in the test chamber will be about 100°F. below zero.

Named the Arnold Engineering Development Center, the new facility will be available to all parties interested in aeronautical research, including the Air Force, Army, Navy, government, industry and science.



120-ton stator section for the world's largest air compressor is machined on a 40-foot vertical boring mill in the Westinghouse plant at Sunnyvale, Calif.

Hoisted above the motor-drive building roof, the giant 75-ton stator section of an 83,000 horsepower motor makes an impressive silhouette. The huge part will be lowered through a hatch to a concrete pedestal.

SIDE-BY-SIDE VS. TANDEM TRAINERS

(Continued from Page 8)

be an important factor in flight training, but maximum utilization of all of its benefits is dependent upon the proximity of the student to the instructor. In presenting the advantages of side-by-side trainers, it is repeatedly apparent that this proximity is the one most important factor to which most of the advantages can be ascribed.

The most common complaint heard from all instructors who have to ride the back seat of a tandem trainer is the limited visibility from this position. Significantly enough, the majority of these complaints are in connection with visibility during the landing approach, a time when the instructor most needs maximum visibility. This problem is non-existent in the side-by-side trainer. The field of vision is almost identical for student and instructor—both have excellent visibility forward, up, back and to the sides. In addition, in the side-by-side, both the student and instructor are able to use the same reference points at all times.

As indicated earlier, instructor evaluation of the student is a very important aspect of primary flight training. It is uneconomical in terms of both time and money to carry inapt students in the training program. In a tandem arrangement the instructor must rely almost entirely on indirect, external signs or indications of the student's progress. The instructor's only visual contact with the student is the back of the student's head or a portion of his face reflected in a small mirror. Only side-by-side seating makes it possible for the instructor to continuously monitor the student's cockpit technique and progress in the direct, unhampered manner most desirable in flight training.

Not to be overlooked is the fact that instructors work better, teach more effectively and can instill confidence in the student faster if they themselves are not under tension. The tendency of the instructor to build up tension as the day progresses will be eliminated because the instructor will not be under the constant strain of trying to detect danger signals through second-hand indications as in the tandem. The sources of tension will be reduced in a side-by-side arrangement because of the instructor's ability to keep constant and close visual check on all of the student's actions. This will in turn result in more uniform instruction throughout the day.

Students learn by doing. This is best illustrated by an example. On a landing approach in a tandem trainer, the instructor notes that the student should add a little power. The student may be ready to make this same correction but being a little slower because of his inexperience, he finds that the instructor is already advancing the throttle. The student feels deprived of an opportunity to display his judgment and the instructor considers the student slow to learn. Had the instructor been sitting beside the student, he could have noted that the student was getting ready to make the correction. In the side-by-side trainer the tendency to correct students too soon will be lessened and as a result a student will learn faster.

In tandem trainers, since the instructor is detached from the student, except by the inter-com, it is impossible for him to judge whether he has explained so much that the student is confused or explained so little that the student could not fill in the gaps. In a side-by-side the instructor would be better able to judge the amount of verbal instruction required by the student for a clear understanding of what is being taught.

One problem to be overcome early in the student's training is his lack of confidence or apprehension. This apprehension is due to lack of familiarity with his surroundings, and the fact that he has yet to gain confidence in his instructor, the airplane and his own ability. In the side-by-side, the student is able to observe the relaxed manner of the instructor, he sizes up the instructor's ability more quickly and he notes the ease and apparent simplicity with which the instructor does the job of flying the airplane. The proximity of the instructor makes it easier for the student to ask questions about his unfamiliar surroundings and with the reduction of his tensions and increasing familiarity with his surroundings, his progress is considerably speeded up.

The instructor is able to make maximum use of the demonstration technique in teaching procedures. In addition to explaining to the student the sequence of operations, he can show the student the steps and explain his actions as he teaches. The student can see just what the instructor does and how he does it. The instructor, in turn, can readily observe and correct the student.

An important consideration in any flight training program is the safety of the student and the instructor. In the tandem the instructor must be prepared for movement of the wrong control by the student by holding that control down during the critical period. He will find it easier to prevent the student from moving the wrong control in the side-by-side. Misunderstandings between the student and instructor over who has control of the aircraft would be materially reduced as a source of accidents, as would differences in readings of front and rear cockpit instruments. The improved visibility for the instructor should be a factor in reducing ground taxi accidents and also mid-air collision.

Last, but not least, the elimination of considerable duplicate equipment, such as radio control boxes, transfer controls, duplicate instruments and duplicate secondary controls from the side-by-side trainer would reduce the sources of some maintenance problems, thereby improving the availability of aircraft on the flight line.

In conclusion, no training program can be better than the tools it has to work with. In the case of flight training the principal tool is the airplane itself. Through experience, the Services' flight training programs have evolved into efficient and well organized pilot training schools. The only major area where it would appear that further gains can be made is in the improvement of the airplane to make it a better tool with which to train pilots. Any sought for improvement could hardly be better than the change to a side-by-side trainer and the opportunity it provides for making full use of the known and proven concepts of Audio-Visual learning.

CERAMIC RESEARCH

(Continued from Page 2)

ent structural strength to perform their functions.

Ceramics, as an art, date back to earliest civilization. The term originally referred only to pottery. Within the last half-century, science has broadened their usage until now ninety percent of all industrial products are either made with ceramics or depend upon them in their manufacture.

The emergence of jet-type power plants has accelerated the development of

(Continued on Next Page)

CERAMIC RESEARCH

(Continued from Page 20)

high temperature ceramics. Essentially, these engines depend upon extreme temperature differentials in converting heat energy into work. Consequently they have created a tremendous demand for materials which will withstand elevated temperature, vibration and thermal shock.

Ingeniously, metals have been formulated to perform these tortuous tasks. But, many metallurgists question the capacity of unprotected metals to meet the need at temperatures beyond those now experienced — or above 1800°F. This point seems to be about the limit of endurance for the known metals which are suitable for the applications.

Ceramics offer the best promise of a solution. They have no melting point but gradually deform under stress at temperatures much higher than metals can sustain in service. Since they are saturated oxides of metals, ceramics are extremely resistant to oxidation—a shortcoming of metals. However, ceramics alone do not possess the structural strength and mechanical shock resistance of metals. Obvious answer: a combination of metals and ceramics.

Metal-ceramic combinations are easier to imagine than to obtain. The first successful ceramic coatings for high temperature steels were developed by the National Bureau of Standards in 1947, after six years of research. This new ceramic possessed a coefficient of thermal expansion that closely matched the stainless steels. Consequently, it adhered to them over a wide range of temperatures. The Ryan development laboratory placed these ceramics on test to validate their usefulness for actual service with high temperature exhaust systems for aircraft engines.

In conjunction with Boeing Airplane Company and Pan American World Airways, a series of specially made exhaust system components were placed in service with Boeing Stratocruisers in transpacific flights. These exhaust "headers" were made from a variety of metals including stainless steels, Inconel X, Hastelloy C, Haynes Stellite N-155 and Armco 17-14 Cu-Mo. Some were coated with National Bureau of Standards ceramics and others were left uncoated. At intervals of approximately 800 hours the test headers were removed and sent to the Ryan development laboratory where they were carefully analyzed. Then, they were returned to service. At this time, many of these components have attained a service test life of more than 3,000 hours and the program has become the most comprehensive test project of its type.

Metallographic examinations of the Ryan test headers have shown that the National Bureau of Standards ceramic coatings, of which A-418 is the most recent type, have retarded the occurrence of oxidation, carbon absorption and corrosion attack usually experienced in the application. As a result of this protective feature, the exhaust system components have had their service life extended from 50 to 100 percent.

In conjunction with California Metal Enameling Company, Ryan produces most of the ceramic coated exhaust equipment used by aircraft. Included in these applications are components for Boeing 377 Stratocruisers and C-97 Stratofreighters, Convair 240 and 340 Liners and Fairchild C-119 flying boxcars. Also, Ryan has built thousands of ceramic coated combustion chambers for General Electric J-47 jet engines and Continental engine manifolds for General Patton Tanks.

Ryan-Cameo are successfully building large, high temperature components which require special treatment. Made of stainless steel, these structures are exceedingly thin-gauged and would not survive in service if they were not coated on both sides with ceramic coatings. To provide extra strength and insulation properties the sections are louvered and corrugated.

Exceptional methods had to be developed in order to obtain uniform coatings on the corrugated surfaces. Also, special cleaning methods had to be developed because standard sandblasting methods could not be used, due to the thin gauges involved. Another technique was employed to prevent warpage of the thin sections in the furnace fusing process.

Because A-418 ceramic coatings are flux-like in character, it is possible to arc-weld through them with good results. Ryan production takes advantage of this facility by building large structures in small component parts and welding them together after they have been ceramic coated. In this way, the ceramic coating process is simplified and economic savings are made because the parts are more accessible for coating purposes.

The ceramic coating melts, floats on the weld metal from the heat of the welding arc and combines with the welding flux. Along the weld zones, the adjacent ceramic material smoothly blends into the weld without spalling because of the good thermal shock resistance of the coating. This advantage is also effectively used in the fabrication of experimental jet engine assemblies which are partly ceramic coated, with uncoated portions within the structure.

The Ryan development laboratory continually tests every available ceramic material in its test chamber facility. This arrangement utilizes a burner which burns high octane fuel within test headers coated with the ceramic to be evaluated. Flame temperature is 2200°F. The ceramic is heated to 1700°F. skin temperature for a period of 25 hours. In these comparative tests, A-418 ceramic coatings have displayed less physical change due to temperature than any other tested. Ryan also uses the test facility to aid production in determining the proper thickness for coating specified parts or to decide such questions as the number of firings which are most desirable.

'Mercy' Flight Made By Navion

A Ryan L-17 Navion plane was used recently for an unusual "mercy" flight in Austria.

A six-year-old Austrian girl, Eva Maria Markl, suffering from whooping cough, was flown from Salzburg to an altitude of 6,000 feet, on the recommendation of her doctor, who believed the rarefied air would ease her ailment.

The flight was made on authorization of Lt. Gen. William H. Arnold, commanding general of U. S. Forces in Austria. The child was accompanied by her physician, who said that "positive results" were noted after the 35-minute flight. Several days later, the child was reported "visibly much better."

Six-year-old Eva Maria Markl, suffering whooping cough, is helped into Ryan L-17 Navion in Salzberg, Austria, by Capt. Ralph S. Paxman, Army pilot, as her father says "Auf Wiedersehen."

Wright Key Men Here For Conference On J-65

Key officials of Wright Aeronautical Corporation's Wood-Ridge, N. J. plant recently visited Ryan for conferences on the high temperature afterburner and jet engine components Ryan is building for Wright's new J-65 "Sapphire" turbojet engine, which has a rated static thrust of 8200 pounds.

Shown at the conference table after their tour of Ryan facilities, are, left to right, A. S. Billings, Ryan quality control manager; George Hallad, Wright manager of subcontracting; J. M. Cowell, Jr., Wright director of purchasing; Rod McDonough, Ryan eastern representative; Sam C. Breder, Ryan director of customer service; Don Wright, Ryan contact estimating; Larry Limbach, Ryan works manager; L. L. Underwood, Ryan customer service superintendent; Floyd Chitty, Wright manufacturing division; Henry Berlinghof, Jr., assistant to Ryan production manager; Jess Sohn, Wright manufacturing engineer; and Robert Smart, Wright quality control.

COOLING ELECTRONIC EQUIPMENT

(Continued from Page 11)

state conditions are reached.

Present day aircraft are handling the situation in two ways. (1), air cycle refrigeration is used to reduce the air temperature. (2), the equipment is built to withstand the increased temperature. The first method has limitations at speeds above Mach one due to high power consumption. The second method while theoretically the better of the two, has not been attained in electronic circuits. Transformers, relays, magnetic components in general, can meet the present temperature demands while condensers, transistors, crystal diodes, and precision resistors can not. There is little or no hope of this second method keeping pace with aircraft speeds.

The solution to the problem is a cooling system that is independent of aircraft speed and altitude. Any system that is independent of speed and altitude can not use atmospheric air as a direct heat transfer medium or heat sink. This means that either the heat must be stored in the aircraft for ejection at a later time, or it must be ejected from the aircraft in flight. The first can be accomplished by allowing the heat to increase the temperature of a high specific heat material and dissipating the heat at lower altitudes and speeds or on the ground after the flight. This amounts to nothing more than a time lag system and is applicable only to short flights and low power dissipations.

The latter can be accomplished in several ways. (1), the fuel used by the aircraft could be used as a coolant before it is burned in the engine. (2), a solid could be sublimed in the presence of a liquid coolant. In this case, the gaseous products of the sublimation are piped overboard. (3), a liquid could be made to boil in a heat exchanger or in passages in the equipment, thus absorbing heat. The gas would either be piped overboard or expanded for further cooling advantages if altitude permitted.

Fuel cooling has many possibilities. The specific heat of jet fuel is about 0.6 calories per gram and its density is about three quarters that of water. Its effectiveness in a heat exchanger can be seen to be approximately half that of water. The flow rate in a jet engine of 10,000 pounds thrust at cruising speed would amount to some thirty gallons per minute. One can compute that for each degree centigrade rise in fuel temperature that 2.5 kilowatts of energy could be absorbed by the fuel. The magnitude of the allowable temperature rise of the fuel is not large but it need not be large as shown by the following example. Taking the specific heat as 0.6 calories per degree centigrade, and a temperature rise of 20 to 30 degrees centigrade, it is evident that 50 or 75 kilowatts of heat could be dissipated. This is more than ample for any electronics combination in aircraft today.

The sublimation of a solid does not offer as much on a weight for weight basis as either of the other two systems. Solid refrigerants, while easy to use and acquire for experimental setups, are just the opposite for combat planes. By necessity, the solid refrigerant must be manufactured at its locality of use. This would not be practical, for the quantities needed would be large and the machinery bulky and heavy to produce it.

The boiling of a liquid has moderate possibilities as a heat sink. There are many liquids that could be used. However, none compare to water for latent heat, density, and availability. The latent heat of water is about 600 calories per gram when starting from ground temperature. This means that one gram of water in boiling will take with it some odd 2.5 kilowatt seconds of power. As an example, suppose a radar system of 1 KW dissipation is to be cooled. Water with a suitable anti-freeze is stored in a tank as close as possible to the equipment to be cooled. A small centrifugal pump requiring about 50 watts input power would force the water through thin-wall tubing brazed to the chassis of conduction cooled equipment or through heat exchangers in pressurized equipment. The water and steam mixture then returns to the storage tank. The amount of water evaporated will be 3 or 4 pounds per hour. This quantity amounts to less than two quarts. Since the flight time of a fighter capable of traveling at supersonic speed would be a little more than one hour, a cooling system with a moderate heat load using a water anti-freeze solution as its heat sink could be used. This system would be compact, light in weight, require little power, and have maximum simplicity.

Equipment designed to use a heat sink such as this should preferably work about 100° C. However, systems can easily be made to run as low as 80° C. Such a system would incorporate a centrifugal blower to produce a vacuum on the heat sink at low altitudes. This blower would have to have speed control if a constant temperature in the heat sink were desired. Otherwise, it could be left free to run until a pre-set altitude was reached, then shut off. A spring loaded bypass valve could regulate the temperature at all higher altitudes. In most cases the heat inertia of the liquid would be adequate to keep the temperature of the system below the maximum boiling temperature until the airplane climbed above the minimum altitude needed to maintain this boiling temperature equilibrium. Each specific system would have details that would have to be worked out with cognizance of the equipment to be cooled.

In certain equipments, an inert liquid or gas under pressure is necessary for high voltage insulation between wires and components. Transferring the heat

(Continued on Next Page)

developed in the equipment to the heat sink via this liquid or gas is a problem requiring much study and careful design. The basic problem is one of forced convection.

In forced convection, heat is transferred from a surface to a liquid or gas according to the relationship.

$$Q = h A \Delta T$$

where

Q = Quantity of heat
h = Local heat transfer coefficient
A = Area of surface
ΔT = Temperature difference between fluid and surface

The heat transfer coefficient is usually found specifically by experiment, however, it can be found approximately with a relationship due to Reynolds.

$$h = \frac{Cf\ Cp\ P\ v}{2}$$

where

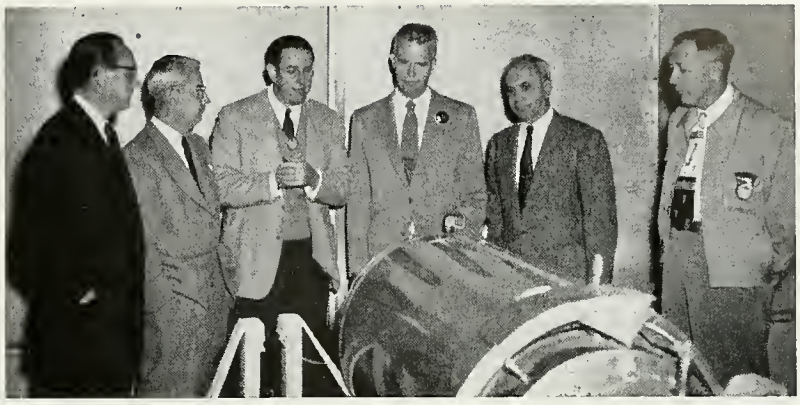
h = Heat transfer coefficient
Cf = Friction factor
Cp = Specific heat of fluid
P = Density of fluid
v = Velocity of fluid in main stream

This relationship is true when the Prandtl number is near unity as it is for air and water at the temperatures to be used for electronic equipment. For other liquids, such as insulating oils, a correction factor must be applied. Friction factor data show that Cf is proportional to Reynolds number and surface roughness. It can be seen that high heat transfer coefficients can only be had at the expense of pressure drop since h is directly proportional to Cf. Pressure drop when using air as a heat transfer agent is usually limited to several inches of water or approximately 0.1 lb/sq. in. This limit is imposed by available blower sizes and speeds. Small centrifugal liquid pumps, however, can operate efficiently at slow speeds and produce pressures of the order of 5 lbs/sq. in.

Let us compare two similar systems, one using air the other water, consisting of a piece of equipment dissipating 1 kilowatt connected with ducts to a heat exchanger. The allowable temperature rise of the cooling medium on passing through the heat exchanger will be 10° C. The pump motor in both cases will have the same power, roughly ⅛ H.P. The volume of flow necessary for air is found to be 175 cu. ft. per minute while for water it is 0.05 cu. ft. per minute. This large difference is due mainly to the volume density difference between water and air and secondarily to specific heat differences.

The pump pressures would be 0.1 lb/sq. in. for the air blower and 5 lb/sq. in. for the liquid pump. With these pressures available, the velocities in the heat exchangers would approach 110 ft/sec for air and 27 ft/sec for water. Reynolds number would be 1×10^5 for air and for water 3×10^3. These values of Reynolds number yield friction factors of 0.006 for air and 0.06 for water. The heat transfer coefficients using the Reynold equation for air would be approximately 0.10 watts/sq. in./sec and for water 600 watts/sq. in./sec. The areas in the two respective heat exchangers thus would have a ratio of some 6,000 to 1. The ducts connecting the equipment to the heat exchanger will be about three inches in diameter for air and one-half inch in diameter for water. The system using water then is much more compact than the air system. When comparing relative weights of the two systems, one must consider the medium on the other side of the heat exchanger. If air is used as the medium of the heat sink, the heat exchanger would be large, and the liquid heat transfer system will be the heavier. If a boiling liquid or fuel were used as the heat sink, the opposite would be true. Neither of these two systems are of practical value but were presented to show the tremendous difference between air and liquid systems.

In the future, when aircraft speeds progress well past transonic speed, and when altitudes of fifteen miles are common place, not only electronic equipment but hydraulic and rotating electrical machinery will also have to be cooled by means other than air. It would appear that fuel would be the best choice for an integrated aircraft cooling system heat sink although liquid evaporation will find its place for small isolated pieces of equipment.



JET POWER—Fairchild jet engine which powers Ryan "Firebee," pilotless target plane, was viewed by Maj. Gen. Dean. Left to right, Lloyd Baldridge, Dean's San Diego host; Bruce Smith, director of enginering; Larry Limbach, works manager; Dean; T. Claude Ryan, president; and John van der Linde, production manager.

General Dean Makes Tour Of Ryan

Maj. Gen. William F. Dean, highest ranking prisoner held by the North Korean in the Korean War, made an unheralded tour of the Ryan plant recently. During a brief vacation in San Diego with longtime friends, Mr. and Mrs. Lloyd Baldridge, Dean met T. Claude Ryan, company president, and accepted Ryan's invitation to visit the factory.

Appearing fully recovered from his ordeal in captivity, the tall man with close-cropped, steel-gray hair, penetrating eyes and kindly smile strode through the plant with brisk efficiency. After the tour, he remarked: "You know, I'm just a doughboy, and when I see the complexity of the products such as you turn out here, I marvel at the genius of my fellow men."

SURPRISE REUNION—When Maj. Gen. William F. Dean visited the Ryan plant recently he met Forrest "Bob" Collins, of the jet building tool crib, with whom he served in a field officers' course at Ft. Benning, Ga. in 1931-32, when both were Army captains.

FIREBEE-HIVE

(Continued from Page 5)

man's small unit can be looked upon as the vanguard of future operational Firebee squadrons. The experience they gain, the problems they solve and the mistakes they make will benefit those who will some day follow. With this object in mind, the Test Center Group, in addition to suitability testing, is compiling the comprehensive data that will be required to properly staff, equip and supply an operational Firebee squadron. This information includes facts on: personnel and equipment requirements; maintenance requirements; range requirements; spare parts needed for sustained flights; mobility of support equipment; endurance of the target at all altitudes; maximum altitude attainable and attrition of targets.

On successful completion of the Firebee suitability testing program, this information will be made available to any units or officers assigned the task of organizing an operational Firebee squadron.

Capt. Kaufman and the majority of his men attended an eight-week's course of instruction in the assembly, operation and maintenance of the Firebee conducted at Holloman last January and February by two Ryan engineeers, Ronald A. Reasoner and John McAllister Reece. Between February and July, when they received their first Firebee for testing, the section was engaged in setting up shop facilities.

The wing launch method is used by the Test Center Group in flying their Firebee missions. The target drones are cradled in specially designed wing racks mounted at each of the outboard wing bomb shackles of a Douglas B-26. Speeding the drone on its way is accomplished by means of the electric bomb salvo switch.

During the first few OST Firebee missions a target was carried on one wing of the B-26, a water-filled ballast tank on the other. Lt. Herbert B. Covell, Capt. Kaufman's assistant test officer, suggested that the B-26 be modified with a duplicate wing rack to replace the ballast. By doubling the capacity of the launching aircraft, the test section can now accomplish two launchings on each mission. Turn-around-time, required in the past to land and load another target, has been eliminated. They now launch one target from the B-26, circle outside the range until parachute recovery of the drone has been accomplished, then return to the range for another launching.

In a typical launching mission, Lt. Covell, a veteran of Korean B-26 action, handles the controls of the B-26 with T/Sgt. Joseph J. Grau acting as direct control operator of the target drone. From take off until launching, Sgt. Grau has direct control of the target through an umbilical cord. Observing the behavior of the "captive" target from his perch in the aft section of the B-26 is S/Sgt. Antoni A. Pogozelski, Sgt. Grau's assistant and originator of the "I Go Pogo" inscription found on each of the targets. Somewhere on the sprawling desert floor below, Capt. Kaufman is at the remote control panel. Nearby would be Bill Berry, Ryan technical representative, serving as advisor in

T-5gt. Joseph J. Grau, Lieut. Herbert 8. Covell and Capt. Glenn O. Kaufman of the Air Force Test Center group inspect a newly assembled Ryan Firebee.

the event of any malfunctions during flight. Once the pre-launching check lists have been completed and the umbilical cord removed, Capt. Kaufman has complete control of the drone from his station on the ground. He won't be able to see the Firebee, but a plotting board will show the target's path and altitude as he controls the flight maneuvers and the recovery system with the buttons and "stick" of his "black box."

Once the launching aircraft is airborne, Lt. Covell puts it into a climbing turn to a downrange heading on the first leg of what will be a rectangular pattern. By the time launch altitude has been reached, Covell has completed the rectangular pattern and picked up his escorting F-86 "chase" plane. In position on the range with all pre-launching checks completed, Covell salvos the target and executes a sharp climbing turn to the right to clear the test area. From take off to launching time the procedure is just a matter of minutes.

After target dropaway, Capt. Kaufman has control of the "bird" from his ground station. Should the drone go out of control, the Firebee's automatic parachute recovery system will go into action and lower the target safely to the ground.

Taking data on the target's performance, Capt. Kaufman "commands" various maneuvers from his "black box." When the target's fuel has been expended he "commands" the parachute recovery of the drone and notifies Lt. Covell of the recovery by VHF radio. Covell returns to the range with the second drone ready to launch and the procedure is then repeated.

Capt. Kaufman plans to eliminate the F-86 "chase" plane from the procedure in the near future. Its function has been to report via VHF voice radio the behavior of the "bird" in flight. Explains Capt. Kaufman, "We plan to eliminate it soon because future operational outfits won't have the benefit of an aerial observer during their Firebee missions."

When operational suitability testing of an item, such as the Firebee, has been completed successfully, then the item is ready for operation in the field. The facts and figures that Capt. Kaufman and his men are now compiling on every aspect of Firebee operations will then prove invaluable.

ON THE COVER

En route to Ryan's "Open House" where they were eye-catching exhibits, these two weapons of war are both equipped with Ryan exhaust systems and Continental engines. The hovering Piasecki HUP-2 Navy helicopter has a Ryan manifold and cooling shroud to serve its Continental 550 h.p. engine. Ryan exhaust equipment also handles the hot gases from the 810 h.p. Continental engine of the Marine Corps M-47 General Pattan tank. Accepted as the quality standard, Ryan exhausts are in planes, blimps and trucks.

GIANT JET

(Continued from Page 13)

in a limited time through research techniques. Tremendous sums of money are committed on the probabilities of their success. With the J-57, Pratt and Whitney have won their wager against time.

Only a few basic features of the new engine's interesting design can be revealed because of military restrictions. Following the trend which has been championed by American designers, it is an axial-flow type. This configuration for the compressor section substantially decreases the cross-sectional area of the engine for a given amount of thrust, over the centrifugal compressor type. Immediate aerodynamic advantages result from the more compact nacelle and wing installation and reduced drag which can be realized.

The Air Force states that the J-57 has the lowest specific fuel consumption of any turbojet in production for them. In the past, fuel consumption has been one of the inherent drawbacks of the jet engine. In 1944, specific fuel consumption for a typical turbojet was 1.25 pounds of fuel per hour per pound of thrust. Continued improvement has brought this figure down to less than one pound.

One of the best ways to improve fuel consumption is by increasing the pressure ratio. Undoubtedly, the J-57's remarkably good behavior in using fuel efficiently is due to its unusual dual compressor design which gives the engine a high compression ratio.

The dual, or split, compressor design not only makes possible high compression ratios but also provides fast acceleration and increased operational flexibility. This innovation was pioneered by Pratt and Whitney and has subsequently been adopted by Bristol in England.

The J-57 was given its first ground test run in June, 1949. First model to fly was taken aloft in April, 1951, and lowered from the bomb bay of a Boeing B-50 bomber. Later the engine was flight tested with a North American B-45 jet bomber which could fly at speeds and altitudes more closely approximating the conditions which the J-57 was groomed to experience. In April, 1952, eight J-57's took a Boeing B-52 Stratofortress aloft on the first of many successful flights.

Enthusiastic over the results of their engine's flight performances, Pratt and Whitney believe that they have achieved a two-year advance over any other turbojet in production. In addition, they feel that the J-57 is a basic new design which will lend itself to continued development.

Visitors from Here and There

TITANIUM EXPERTS—Ryan's significant research into the adaptation of titanium to aircraft components was examined recently by two experts from the Wright Air Development Center production resources division. Conferences were conducted on the possibility of increasing the scope of Ryan's prsent Air Force contract for the development of manufacturing techniques with titanium. This metal is being studied as a possible replacement for other metals, primarily stainless steel, in supersonic aircraft which generate considerable heat through atmospheric friction.

Left to right, inspection a titanium subassembly, R. T. Jamison, Wright ADC industrial specialist; W. M. "Mac" Cattrell and Ralph Haver, of Ryan engineering; Lt. Col. A. Altglas, chief of the special aircraft equipment branch, Wright ADC; and E. F. Mellinger, assistant superintendent, manufacturing engineering.

NAVY AIR CHIEF—Rear Adm. Apollo Soucek, chief of the Navy Bureau of Aeronautics, at right conferred here recently with T. Claude Ryan, left, president, and Bruce Smith, center, Ryan director of engineering, on advanced aircraft work being performed at Ryan.

FROM ROLLS-ROYCE — Lord Hives of Duffield, chairman of the board of Rolls-Royce, Ltd., is shown at right with Bduce Smith, left, Ryan director of engineering, and T. Claude Ryan inspecting jet engine component during the Briton's recent tour of Ryan.

SWEDISH AIR FORCE—Lieut. Col. Artur Fransson, director of materials laboratories, Royal Swedish Air Force, recently inspected the Ryan engineering laboratories as part of a nationwide tour of aircraft plants. He was shown sheet metal welding procedures, laboratory controls, etc. during his visit here.

Shown examining a jet engine transition liner are, left to right, Hugh Hix, metallurgist; Wilson G. Hubbell, assistant chief of the engineering labaratories; Fransson; J. R. "Bob" Fullerton, welding engineer; and Dave Adams, metallurgist.

Navion Used In Secret Development Work

A Ryan Navion is being used in development of the Northrop Snark B-62 pilotless bomber, but the exact manner in which it is employed remains secret, as are most of the details of the entire project. Only a hint regarding the work of the Navion is provided in photo at left, in which two Northrop employees are examining the special radio antenna on the under fuselage. The Navion, which carries an "experimental" designation, is shown in flight, at right.

JET AGE TOOLS

(Continued from Page 17)

the jet engine age has fathered a new generation of more massive, accurate machine tools. Capable of jewel-like precision, many of these tools have obsoleted their World War II counterparts because of stepped up accuracy.

Outstanding as an example of a high precision jet engine is the Pratt and Whitney J-57 for which Ryan builds formed, welded and machined, high temperature components. Rated as the world's most powerful turbojet, the J-57 design demands exceptionally high accuracies in the formation of its vital structures. Also, contributing to this fact is Pratt and Whitney's well deserved reputation for building high precision aircraft engines and machine tools.

With increased tempo of J-57 production, a swelling flow of new machine tools has arrived at Ryan to augment the $4 million worth of facilities in the plant. Selected at random, a number of these machines illustrate the exacting needs of the modern jet engine from a fabrication standpoint.

RADIAL DRILL

The largest of Ryan's drilling facilities is a recent acquisition obtained for the J-57 program. It is a Carlton radial arm drill which has been especially designed for accurate drilling, reaming and boring operations. The tool incorporates a massive column, three heavy, box-section bases and an exceptionally rigid arm and head. Machine design is unique in that the main drive gear is located at the lowest point in the head and drives the largest diameter of the spindle. This innovation provides maximum torque transmission from the 15-horsepower electric motor and avoids spindle twist and vibration.

Although huge, the Carlton is extremely flexible and smooth in operation. 36 spindle speeds with a range of 100-to-one are available, giving 24 to 2400 r.p.m.'s. Duplicate push-button controls are located on both sides of the head so that the operator can use either hand in the work. Rapid traversing and clamping of head, arm and column are electrically controlled. No lever is needed to raise or lower the radial arm.

With special tap leads included in its design, the Carlton can be used to perform precision tapping, cutting a prescribed number of threads to the inch with the exactness of a precision tapping machine. This is in contrast to most radial drills in which the taps simply screw themselves into the metal.

The three individual bases permit the use of the drill with three large fixtures. In this way, complete advantage can be taken of the machine's usefulness without time consumed while parts are installed and removed from fixtures.

CINCINNATI MILLING MACHINE

The milling machine is often called the backbone of the machine tool industry. It was invented by Eli Whitney in 1818. Among the milling machines at Ryan, the latest type is the Cincinnati Universal Milling machine which plays an important part in the machining of J-57 jet engine parts.

This versatile tool embodies two milling heads, each powered by separate electric motors. Capable of performing both horizontal and vertical milling tasks, the Cincinnati machine takes the place of two ordinary millers.

Because the heads are individually driven, a variety of types of work can be turned out. A single part can be both horizontally and vertically milled at the same time. Two parts can be milled, in separate fixtures, simultaneously. A part can be machined while another is loaded or unloaded from its fixture, saving time otherwise lost during this process.

The flexible tool is especially designed for heavy milling cuts combined with high precision and a wide range of spindle speeds. Spindle speed ratio of 100-to-one is available with 32 feed speeds. Even, demanding jig boring operations can be accomplished on the Cincinnati because the column, table and carriage are fitted with dial indicators and calibrated standards.

GENERAL ELECTRIC X-RAY

Probably, the best indication of the high quality demanded in the fabrication of the J-57 engine is the X-ray inspection requirement. All fusion welding, of which there is a generous amount, must be 100 percent x-rayed to disclose any imperfections. A fairly common requirement in examination of castings and forgings, 100 percent radiographic inspection is a new demand in connection with all fusion welding on a jet engine.

X-ray is a fast, accurate method for ferreting out unsuitable welds which may

(Continued on Next Page)

'Here's How It's Done'

America's oldest licensed pilot, 91-year old James W. "Dad" Montee, of Los Angeles, explains with gestures to Claude Ryan, company president, how he flew a jet plane recently. Montee was guest of honor at local air shows here celebrating the 50th Anniversary of Powered Flight. Ryan was chairman of the San Diego committee for this observance.

harbor defects that are not discernable to the unaided eye. Tiny cracks, inclusions and porosity show up as dark lines and areas under its probing scrutiny. It is the most searching of all inspection techniques, going beyond other methods such as Zyglo and dye penetrants.

When 100 percent x-ray inspection is installed it accomplishes two results: (1) it insures that only perfect welds are delivered and (2) it acts as an immediate check on welding techniques used in production. Fortunately, Ryan has experienced extremely few cases of defects that indicated faulty methods, in the seven months during which this procedure has been in effect.

A complete, new x-ray facility was installed in the jet engine building to accommodate the stepped up requirements which the J-57 x-ray inspection program incurred. This facility is built around a General Electric OX-250 industrial x-ray unit which is suspended from a jib crane. It can be raised or lowered 16 feet and rolls back and forth 8 feet on the crane arm. To give this unit maximum mobility, the head turns through 360 degrees on its vertical axis and 270 degrees around the horizontal axis.

Heart of the unit is a Coolidge line focus tube equipped with a hooded anode which increases the output. A small focal spot is employed which provides fine detail and high quality radiographs with relatively short focal film distance.

The tube is immersed in cooling oil which circulates through cables to a radiator. Maximum output of the tube is 250,000 volts at 10 milliamperes. With this high power it is possible to shoot pictures through four-and-a-half inches of steel.

LODGE AND SHIPLEY T LATHE

The T lathe has come into being to fill a need for facing, turning and boring thin-walled sections of large diameter and short length. It gets its name from the employment of a bed with a carriage-carrying section at right angles to the lathe centerline.

Ryan's new Lodge and Shipley T lathe has two cutting heads and will swing a 60-inch diameter part. It occupies less than half the space, and costs far less, than the smallest conventional type lathe which will accommodate 60-inch sections. The cutting heads may be operated either independently or simultaneously to perform facing, turning and boring. The big face plate will rotate in either direction, saving extra time required for changing set-ups.

The machine tool will play a precision role in the J-57 program because of its special advantages. All controls are centrally grouped in a location which permits the operator to watch the cutting tool as he makes fine adjustments.

Particularly valuable is the T lathe's variable speed driving arrangements which can be applied to automatically produce a constant cutting speed. This is important in contouring very wide faces, such as those found in jet engine and turbine parts.

While much of the work that is chucked or clamped to the face plate of the machine is of the open ring type, work-pieces which include shafts or extensions can also be handled. The headstock spindle is furnished with a very large hole through which these extensions may be inserted. Loading and unloading of large, heavy work-pieces is facilitated by the complete access to the front of the machine and the extended carriage traverse to the end of the bed.

FRORIEP VERTICAL TURRET LATHES

To augment the array of Bullards and Kings which Ryan uses, four German-made Froriep vertical turret lathes were installed and pressed into J-57 service. Basically, these machines perform similar functions to the better known American tools of the same family. They face, turn and bore large or small parts with high precision.

Their 55-inch diameter tables will handle parts weighing up to 4 tons at turning speeds between 2.8 and 140 r.p.m.

(Continued on Next Page)

AGREEMENT REACHED—After a brief period of harmonious negotiations which resulted in wage increases and other benefits for Ryan welders, contract was signed by negotiators, left to right, James W. Bunnell, personnel manager; Robert F. Smith, training supervisor; William J. Kairot, Jr., president, United Aircraft Welders, Local 52; Tony A. Gonsalves, of union negotiating committee; Muriel L. Parks, chief shop steward, and Walter J. Herbert, wage administrator.

Moral Rearmament Ideals Figure In Welders' Contract

The principle of Moral Rearmament, emphasizing "what's right" rather than "who's right," was a major factor in swift agreement between Ryan Aeronautical Company and Local 52, United Aircraft Welders, an independent union, on terms of a new contract, James W. Bunnell, Ryan personnel manager, and William J. Kairot, Jr., union president, disclosed recently.

The improved vacation, holiday and insuring benefits now in effect were included in the contract.

"Moral Rearmament, which has settled labor disputes in other parts of the country, believes that disagreements should be ironed out on the basis of what is right, rather than who is right," Kairot said. "This eliminates unreasonable demands by either side from the very beginning of negotiations."

"We discovered in the Ryan negotiations that when both sides apply such principles, swift settlement replaces prolonged argument."

Negotiators for both sides pointed out that this new bargaining principle introduced in San Diego labor-management relations avoids disputes over retroactivity often caused by long delays in reaching agreements. In this case, the increases became effective even before the expiration date of the old contract.

Kairot, a welder in the Ryan welding laboratory, became interested in the Moral Rearmament movement here last summer, and with his wife attended the Moral Rearmament World Assembly in Caux, Switzerland, last September and October.

Negotiators for the union were Kairot, Tony A. Gonsalves, and Muriel L. Parks, chief shop steward. Representing the company were Bunnell, Robert F. Smith, training supervisor; and Walter J. Herbert, Ryan wage administrator.

NOW—Major Charles E. Yeager, world's fastest human, who recently established a new world speed mark of 1650 miles an hour, is congratulated by Lawrence D. Bell, president of Bell Aircraft Corporation, which designed and built the record-breaking Bell X-1A, after completing one of the preliminary flights at Edwards Air Force Base, California.

Fastest Human Wears Ryan's Wings

The world's fastest human, supersonic Major Charles E. Yeager, learned to fly in a Ryan PT-21 training plane at the Ryan School of Aeronautics at Hemet, California. Yeager took his primary flight training at one of the three Ryan schools where 14,000 cadets were trained during World War II.

He entered the Ryan school in the Fall of 1942 as an Air Force Corporal from Hamlin, West Virginia. Expecting to graduate as a Staff Sergeant, Yeager emerged as a flight officer and began his stratospheric career.

It was a fast switch from the 116 miles-per-hour Ryan PT-21, in which Yeager soloed, to the supersonic Bell X-1 but he made it within five years. On October 14, 1947, Yeager kissed Mach 1 "good-bye" as he pushed his rocket-powered streak of speed to 1000 miles an hour.

He was the first man to crash the sound barrier, doing it with a whopping 250 miles per hour to spare. His X-1 flights took the terror out of high speed flight and opened up a new world where the speed of sound is merely the jumping off point. Undoubtedly, F-86 Sabre jet pilots in Korea, who often dove through the sound barrier in combat, owe their impunity to Yeager's pioneering.

Not content to rest on such Herculean achievement, Yeager again ventured into the unknown to do the unbelievable. Last year, he shouldered another man-carrying "missile," the Air Force X-1A, to the record-shattering speed of 1650 miles per hour. Again, he herded his hungry speed animal into an unexplored world. From these flights, the Air Force is gathering valuable aerodynamic data which will be applied to missiles as well as manned aircraft.

THEN—Maj. Charles E. Yeager as he appeared on graduation from the Ryan primary training school at Hemet in 1942.

Last November, Yeager attended the Air Power show at Miramar which was held in celebration of San Diego's observance of the 50th Anniversary of Powered Flight. There, he met T. Claude Ryan, President of Ryan and Chairman of the San Diego Committee for the 50th Anniversary activity. Remarking, "I'm certainly glad to meet the man who ran the school that taught me to fly," Yeager explained that he was a member of Class 43-C at Hemet 11 years ago.

Today, the needle-nosed Bell X-1 is suspended proudly from the ceiling in the Smithsonian Institution, beside the Wright Brothers' "Kitty Hawk" and Lindbergh's "Spirit of St. Louis," which Ryan built in 1927.

JET AGE TOOLS

(Continued from Page 27)

Main drive is provided by 50-horsepower electric motors. Controls are push-button type with an electromagnetic disc clutch installed to insure fast, safe operation. Push-button controls are grouped together on a swivelling pendulum to make them readily accessible to the operator.

The 39,000-pound machines will work on parts that are 44 inches tall as well as very small components. For instance, Ryan recently arranged 20 small external fuel tank fittings on Froriep beds in pie-shaped fashion and machined all of them to exact inside and outside radii, with one set-up.

KNAPP STRESS RELIEF FURNACE

Because of the closely controlled dimensions of J-57 components, all welded assemblies must be stress relieved by heating them to 1200°F. Otherwise, residual stresses, caused by the application of localized welding heat, would exert forces tending to distort the parts' contours.

For this work, a custom-built Knapp furnace has been installed at Ryan. Tailored to handle the J-57 weldments, the new furnace is charged by rolling a truck of parts on tracks extending through the raised door. Heating is accomplished by burning natural gas in a special combustion chamber on top of the furnace. Powerful blowers thoroughly mix the hot air and circulate it down into the heating compartment, to insure uniform and controlled temperatures.

To avoid the possibility of thermal shock, the heating, soaking and cooling cycles are automatically controlled by electronic means. Since stress relieving temperatures are moderate, no necessity for controlling atmosphere exists.

Ryan REPORTER

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Side-By-Side Training Acclaimed at Home and Abroad

Top flight American and British instructors rate Side-By-Side training technique superior to tandem method in letters to AVIATION WEEK magazine, published here with special permission

LETTERS

Ryan's Trainer

My congratulations to the Ryan Aeronautical Co., and their G. C. Danch on the well-studied argument for a side-by-side flight trainer, as presented in AVIATION WEEK, November 30, 1953.

From my own experience as a WW-II advanced single-engine flight instructor in North American AT-6, I feel that they can rest assured of the support of most, if not all, instructor pilots experienced in tandem-design trainers. Although many hours of experience in the back seat of a tandem trainer do result in a high degree of instructor proficiency in this mode of operation, the inherent basic deficiencies of the design are insurmountable and constitute additional sources of danger in an already hazardous occupation.

The reduction of instructor tension in the side-by-side trainer as a result of his improved command of the situation is, to me, the primary and most real improvement in the design change. This factor alone should so improve the instructor's performance as to overweigh nearly any argument opposing the arrangement.

My sincere regards and best wishes to the designers and builders of the Ryan Model 72 for this step in the right direction.

ARTHUR M. HOCKETT,
Flight Test Engineer
Wichita, Kan.

Side-By-Side in England

I was extremely interested in your article on Page 42 of AVIATION WEEK for November 30th last, in which you quote extensively Mr. Danch's views on the side-by-side trainer layout.

You will, of course, know that the R.A.F. Prentice ab initio basic trainer was designed to a specification dated 1943 and the side-by-side arrangement was decided upon by the staff and students of the Empire Central Flying School which, at that time, included representatives of all the Commonwealth Air Forces and, indeed, it is most probable that Officers of your forces were attending the courses.

There was, in the R.A.F., a quite considerable body of opposition to the idea on grounds which were, naturally, purely theoretical, but as the aircraft came into full use in the Flying Training Schools the practical advantages became so apparent that even the most verbose opponents were silenced. The fact that the next ab inition specification for the R.A.F. in 1948 perpetuated the side-by-side scheme and produced the Provost seems to have set the seal of our Air Staff's approval on this layout.

This means that, so far as the R.A.F. is concerned, all pilots are now trained to "wings" standard in side-by-side trainers i.e. the Provost and the Vampire.

In the last paragraph but one of your article you say that there are many arguments against side-by-side seating and this remark has raised by curiosity. From my knowledge of AVIATION WEEK, I feel certain that it has not been occasioned by any need to consider the feelings of the manufacturers of tandem seat trainers! It would be very enlightening to hear the arguments of those who oppose Mr. Danch's views but they would not appear to be of much value unless they were backed by practical instructional experience of both arrangements.

I, of course, know many of the theoretical arguments but I also know that practical experience has failed to bear them out. If you can find space to permit the opposition to set forth their views I am sure it would be read with great interest by many of your readers including myself.

I am an active pilot who learnt to fly in 1916. 10,265 hours flying over half as an instructor. Still fully aerobatic (including jets) at 55 years of age.

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57 80

RYAN FIREBEE

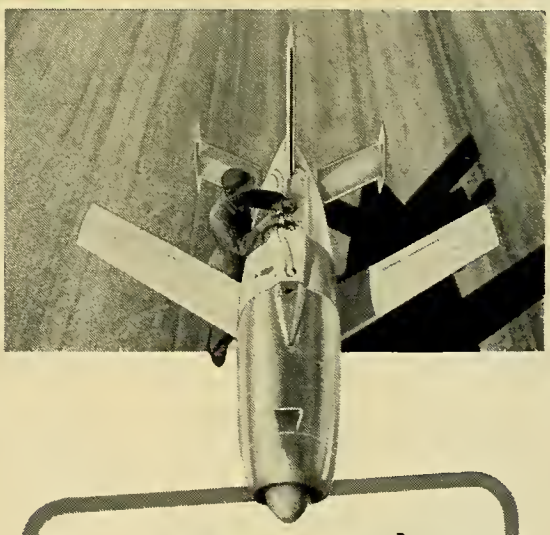
...it lives fast and dangerously!

To keep our air and ground defenders' shooting sharp is the job of the Firebee, America's new high-performance pilotless jet plane. A product of Ryan Aeronautical Company's advanced aeronautical engineering, the Firebee was developed as a joint project of the U. S. Air Force, Army and Navy. It is now being manufactured for use by all three services.

The Firebee carries no human pilot, yet this remote-controlled target plane has phenomenal performance like a modern fighter. It is launched either from the ground or from a "mother" plane and is recoverable by a highly efficient parachute system that lowers it gently to the ground.

Design and development of the Firebee demanded the highest level of scientific talent and technical ability—in the aerodynamic, structural, mechanical, metallurgical and electronics fields. In this latest proud accomplishment, Ryan drew on rich experience gained through its 31 years in the forefront of aeronautical progress.

Because Ryan is *specialized, ingenious* and *versatile* . . . because it is an integrated company with superior abilities in many specialized fields, Ryan is better prepared to accomplish the unique, difficult technical engineering and production assignments of today's high-speed air age.



RYAN

★ SPECIALIZED
★ INGENIOUS
★ VERSATILE

Advanced-type Aircraft and Components
Jet and Rocket Engines and Components
Exhaust Systems for Aircraft
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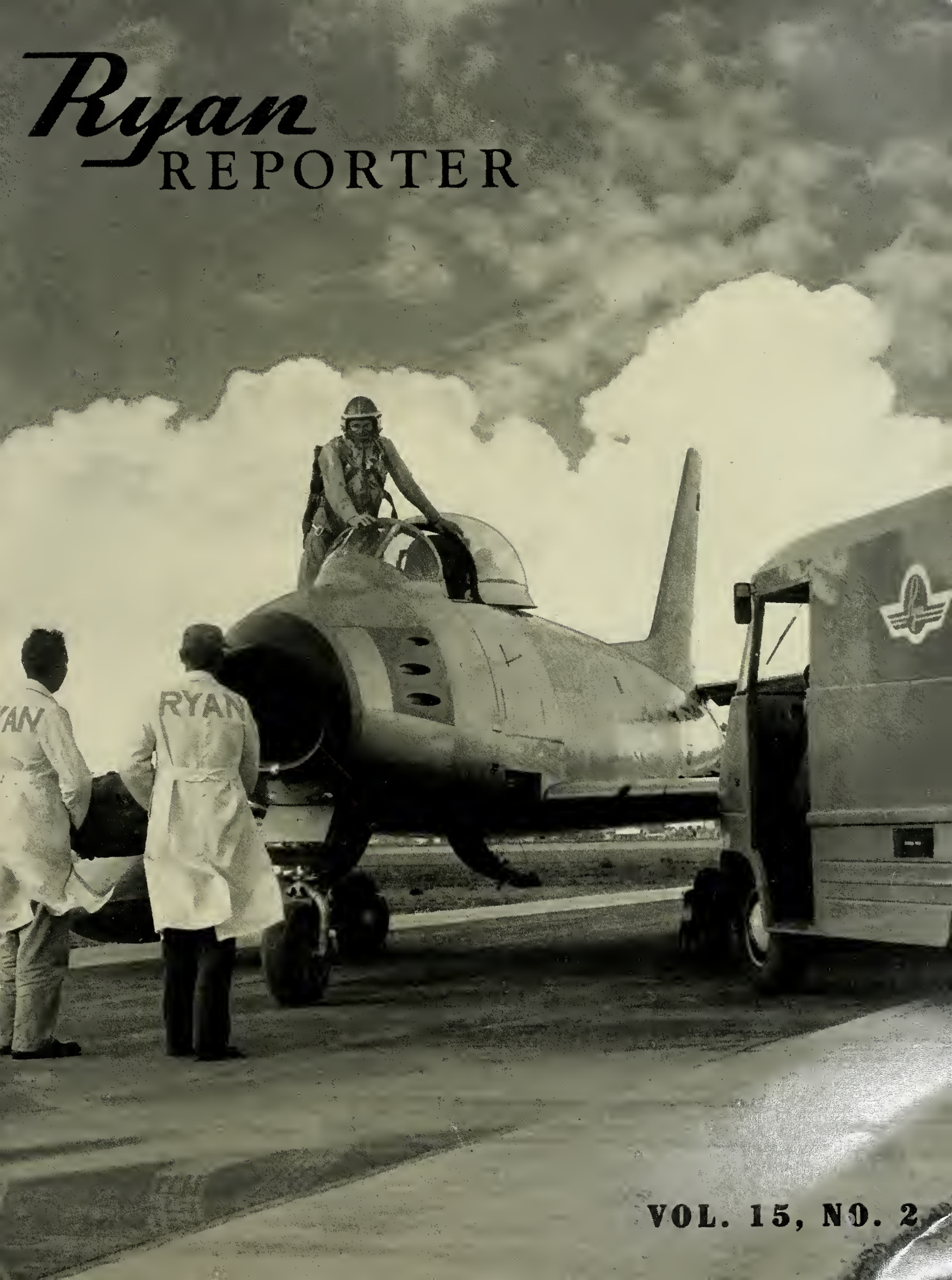
Ceramics for "Hot Parts"
Weapons Systems Design and Management
Aircraft and Power Plant Research
Metallurgical Engineering
Thin-Wall Ducting
Firebee Pilotless Jet Planes

Pioneers in Each ★ Leaders in All

RYAN AERONAUTICAL COMPANY • Factory and Home Offices, Lindbergh Field, San Diego 12, Calif.
OTHER OFFICES: WASHINGTON, D. C.; DAYTON, OHIO; SEATTLE, WASHINGTON; NEW YORK CITY

Ryan REPORTER



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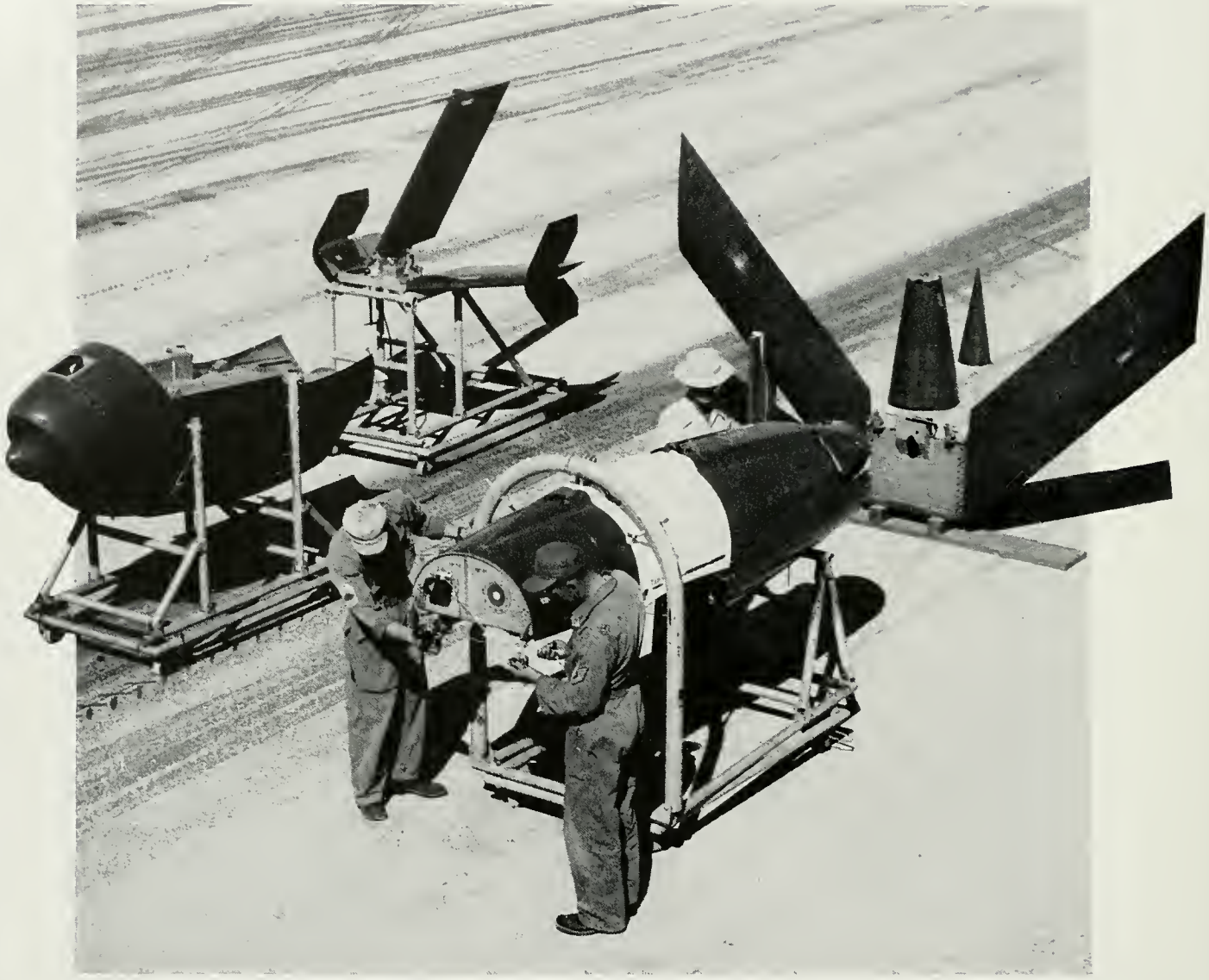

Firebee's major structures are advanced in design yet rugged and simple to assemble. Here, Air Force crew at Holloman Air Development Center prepare fuselage, nacelle, wing, empennage and parachute cone for flight.

DRONE DESIGN

Ryan Firebee is designed to save headaches in the field

RUGGED construction and simplicity of design, permitting rapid assembly and ease of maintenance, are the primary characteristics of Ryan's new Firebee pilotless jet target drone.

Constructed in five major assemblies with simple four-point attachments and self-aligning bolts, the target drone can be fully assembled by two or three men in little more than an hour and with a minimum of handling equipment.

The Firebee target is capable of near-sonic speeds and has performance characteristics similar to those of current American jet fighter aircraft. Remotely controlled from the ground, it can maneuver at varying speeds and altitudes, thereby offering a truly worthy challenge to the skill of gunnery experts and accuracy of guided missiles.

The requirement for an advanced type target such as the Firebee was dictated by the rapid advance of guided missile projects, the development of more efficient radar-controlled anti-aircraft artillery and the demand for more speed in military aircraft.

Conceived a few years after World War II when the Government requested manufacturers to study the possibilities of constructing a high speed, high altitude recoverable target, the Ryan Firebee was designed for anti-aircraft and aerial gunnery training, for use in combat plane interception problems and in guided missile target work by Army, Navy and Air Force units.

The Ryan target design was selected for development, limited production and flight test evaluation under the joint auspices of the three services. The first contract for production Firebees was

placed last year.

The first non-powered glide flight tests were made in the spring of 1951, and the first powered flights were performed in the summer of that year. Since then an intensified test program conducted at Holloman Air Development Center, Alamogordo, N. M., under the technical cognizance of the U. S. Air Force's Air Research and Development Command has resulted in scores of successful Firebee flights. Since each of the services has its own preferred method of launching, Firebees have been launched from the ground in both rail and zero-length launches as well as from the belly and wings of twin-engine "mother" aircraft.

Somewhat less than half the size of present-day jet fighter aircraft, the Firebee target is a mid-wing, all-metal pilotless aircraft with sharply swept-back wings and tail surfaces. The 1800-pound airframe has a span of approximately 12 feet, a length of 18 feet and a height of six feet.

A Fairchild J-44 turbojet engine of approximately 1000 pounds thrust has powered the target in most of its flights. The engine is six feet long, 22 inches in diameter and weighs 300 pounds. The Firebee has also been tested with the J-69 Marbore jet engine, developed in France by Turbomeca and slated for manufacture in this country by Continental.

Ease of general maintenance and rugged construction were given special attention in the design of the target drone. As a result, many novel features directed toward simplicity in assembly for over-all ease in repairing or replacing damaged or inoperative components have been incorporated in the drone. Conical fittings on wing and empennage, with simple four-bolt attachments, guarantee rapid assembly and proper alignment as specified in the basic design requirement.

Thanks to its rugged construction, impact damage to the Firebee following parachute recovery is usually minor and often quickly repaired for subsequent flight.

Construction of the Firebee is of aluminum, magnesium and stainless steel in five major assemblies—fuselage, nacelle, wing, empennage and parachute container (tail cone). The complete target is shipped from the Ryan factory in a group of five containers with a total weight of approximately 2,500 pounds.

The Firebee fuselage is of semi-monocoque construction with formed magnesium and stainless steel skin, dural longerons and dural and magnesium frames. The lower forward section of the fuselage provides for the attachment of the nacelle which houses the engine and engine accessories. A streamlined bullet-shaped fairing is fitted over the engine accessory section when the target is ready for testing or flight.

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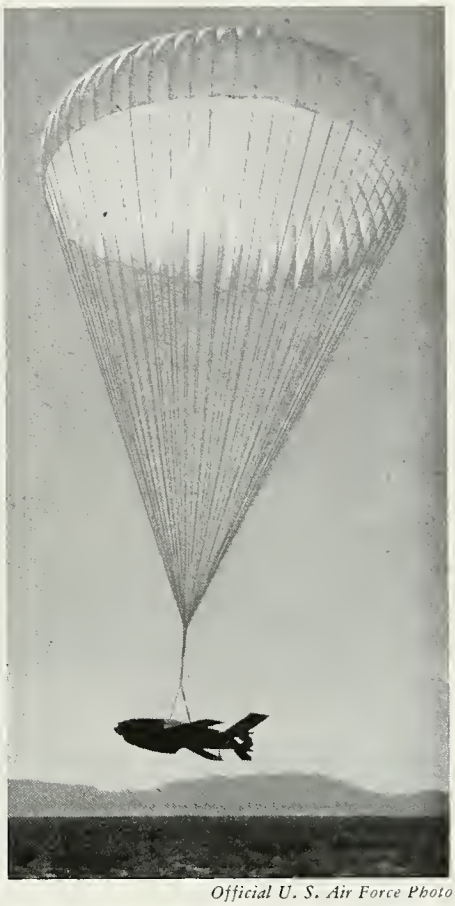
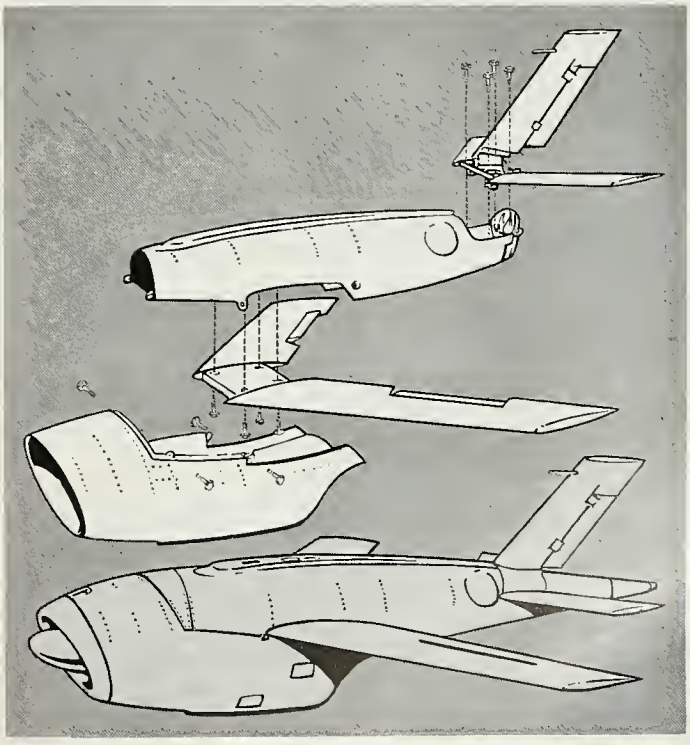


Official U. S. Air Force Photo

Unique twin-parachute recovery system gives drone amazing longevity. Device functions at speeds up to 600 m.p.h.

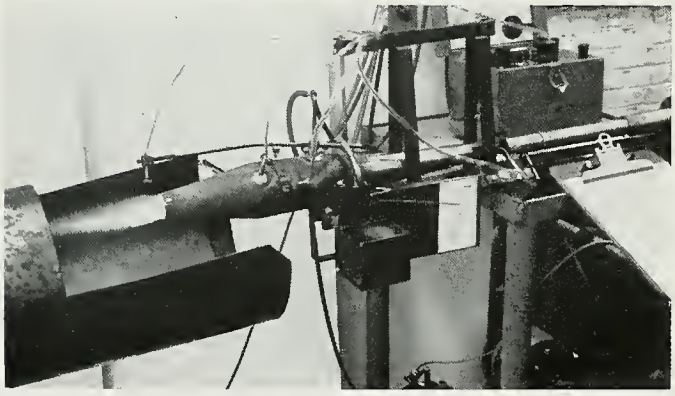
Engine nacelle, housing Fairchild J-44 turbojet, is mated to Firebee. Plane also flies with J-69 Marbore jet engine.

Firebee is designed for easy assembly in the field by means of accessible, self-aligning bolts and 4-point attachments.



The Afterburner Story

Cross-breeding turbojets with ramjets has produced a modern mutation with inherited characteristics from the past



Success of Ryan-designed ramjet combustion chambers in 1944 attracted Navy attention and led to afterburner research.

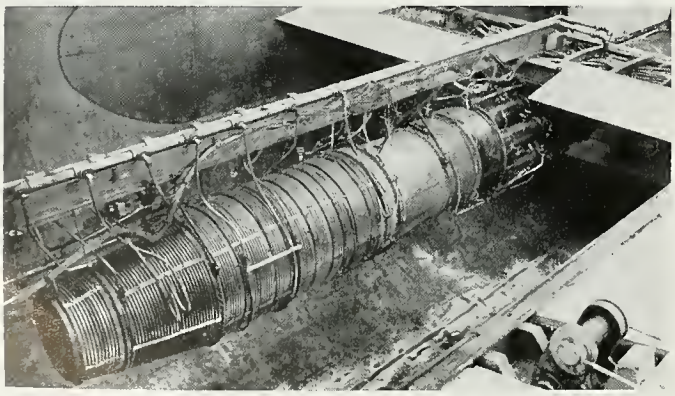
First afterburner built in America by commercial firm was this early Ryan-designed model demonstrated in April, 1946.

In 1946, NACA conducted first altitude-wind tunnel tests of afterburner using original design and G-E's TG-180 turbojet.

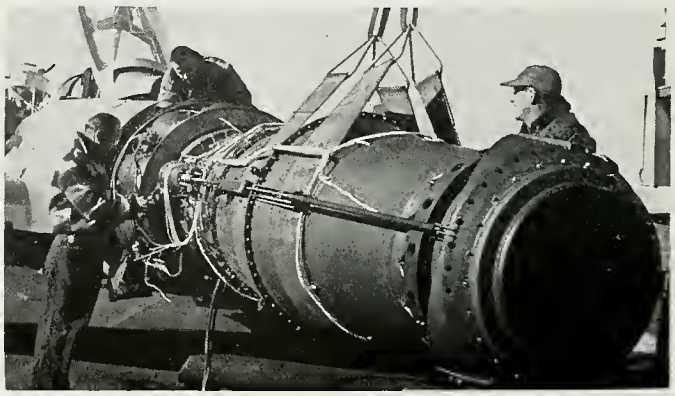
AFTERBURNING is not a new idea. Like jet propulsion, it threads back through history. No individual or organization can be considered the sole pioneer in either achievement. Afterburners, turbojets, gas turbines, steam turbines and internal combustion engines are the brainchildren of dozens of scientists and engineers who labored during the last three hundred years. Each contributed knowledge which makes our present power plants possible.

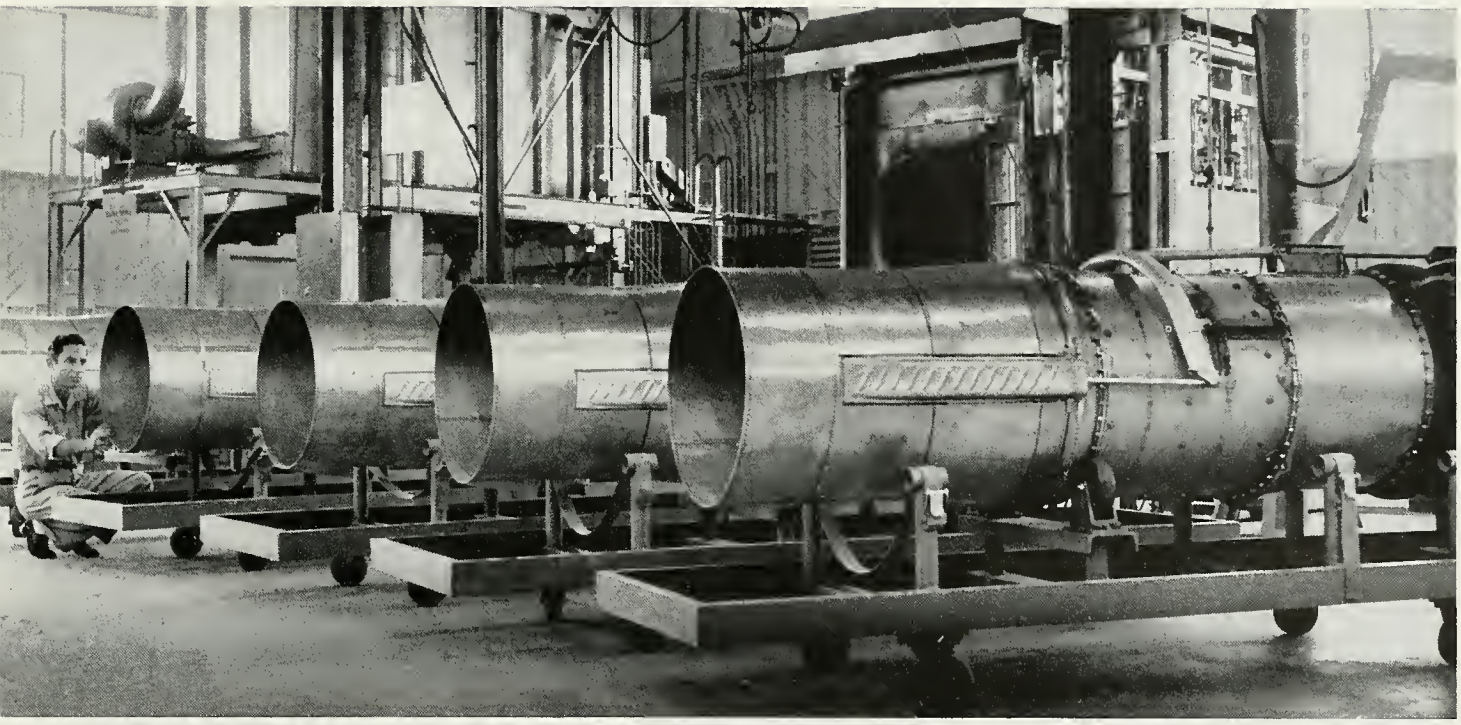
In spite of an obscuring smog of claims, it can be observed

← Fuel cools the seething walls of this early Ryan-designed afterburner shown in test cell. Idea is used in rockets.



Pratt and Whitney Aircraft have been building afterburners for six years and are now producing them for J-57 turbojets.





Ryan is currently building six different afterburners for three major companies. These are for Westinghouse J-46 jet engines.

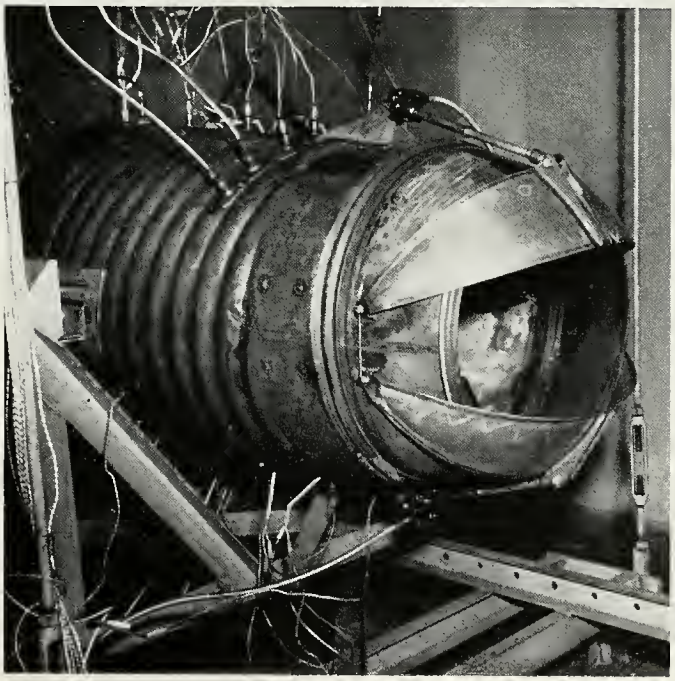
that a number of organizations in the United States performed significant work leading to modern afterburner designs. These would include the National Advisory Committee for Aeronautics (NACA), Ryan, Solar, General Electric, Westinghouse, Wright Aeronautical, Pratt and Whitney Aircraft, Allison and others.

Undoubtedly, the first afterburner in America was built by NACA in 1944. This research was conducted in the NACA's Lewis Flight Propulsion Laboratory and began with the delivery of the nation's first turbojet engine—General Electric's I-A.

Ryan Aeronautical Company began afterburner research in the following year, under contract with the Navy's Bureau of Aeronautics. Ryan produced the first commercially-built afterburner in this country at that time and demonstrated it on

(Continued on Page 20)

Early version of "eye-lid" nozzle which Ryan pioneered for afterburners. This is the system most widely used today.

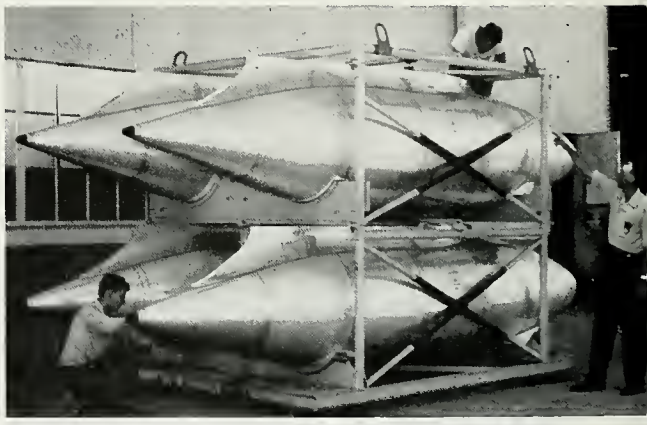


Scheduled for use with J-47 jet engines, these afterburners are built by Ryan and designed by General Electric Company.

500th Boeing multi-purpose KC-97 tanker-transport was hailed by employees who helped build it as giant craft rolled out of plant.

Boeing KC-97s Hit The 500 Mark

Amazing production record is brought into focus by major milestone



Ryan's varied production in the Boeing Stratofreighter program has included external wing fuel tanks, some of which are shown ready for shipment to Renton factory. These tanks extend the operating range of C-97s, thus further increasing usefulness of this versatile plane.

A MAJOR milestone has been passed in the manufacture of one of America's most useful and versatile planes, the Boeing KC-97 tanker-transport.

When the 500th Stratofreighter was rolled out of Boeing's Renton, Wash. plant near Seattle in February, the amazing production record of Boeing and its suppliers, including Ryan, was brought into complete focus for the first time.

For more than 4½ years, output of the double-deck, 350-mile-an-hour sky giants has been on schedule with but one break. That occurred in December, 1950, when the production quota was missed by a single airplane. Such a mark is believed unprecedented for military aircraft of any type, and is tribute to Boeing's coordination of its own assembly program with the operations of more than 200 subcontracting and vendor companies.

Ryan's contribution to this project has comprised one of the major activities in the company's big San Diego plant since late 1949. Ryan has been the sole supplier of the entire rear fuselage and "pod" from where an operator directs mid-air refueling of fighters and bombers. Ryan also has been building floor beams, external fuel tanks and other components, as

Among key personnel concerned with Boeing's KC-97 production are, left to right, Charles Williams, factory manager; Harvey Kent, general superintendent; Andy Doerflinger, general foreman; John Cook, Air Force inspector; Fred Laudan, vice president; and Col. C. J. Eppright, Air Force plant representative.

Ryan-built aft fuselage sections, awaiting mating to forward portion of Stratofreighters, are pictured in their "cradles" on snow-covered ground last winter at Boeing's Renton, Wash. plant. Ryan also has been building refueling pod, external fuel tanks, floor beams and other components for the KC-97.

well as exhaust systems for the 3500-h.p. Pratt & Whitney engines.

On August, 1953, it was revealed, production rate of the 175,000-pound multipurpose Air Force tanker-transports had reached one each working day. Early this year, the Air Force adjusted delivery schedules on a slightly decreasing scale for a six month period, after which it will level off at a somewhat lower rate, with production assured into 1956, one year beyond the original termination time.

Since delivery of the first production type Stratofreighter, the C-97A, in July, 1949, production costs have been sharply reduced. The first C-97A required 5.9 man-hours per pound. The more versatile, heavier KC-97G, the most recent model, needs only 1.1 man-hours per pound. Generally increased manufacturing efficiency has made possible savings to the government—most recently almost $4,500,000 on a completed contract. The Air Force's fixed price-incentive type of contract effects not only substantial savings to the government but additional profit to the efficient manufacturer.

Continuing improvements have been made in the Stratofreighter during the

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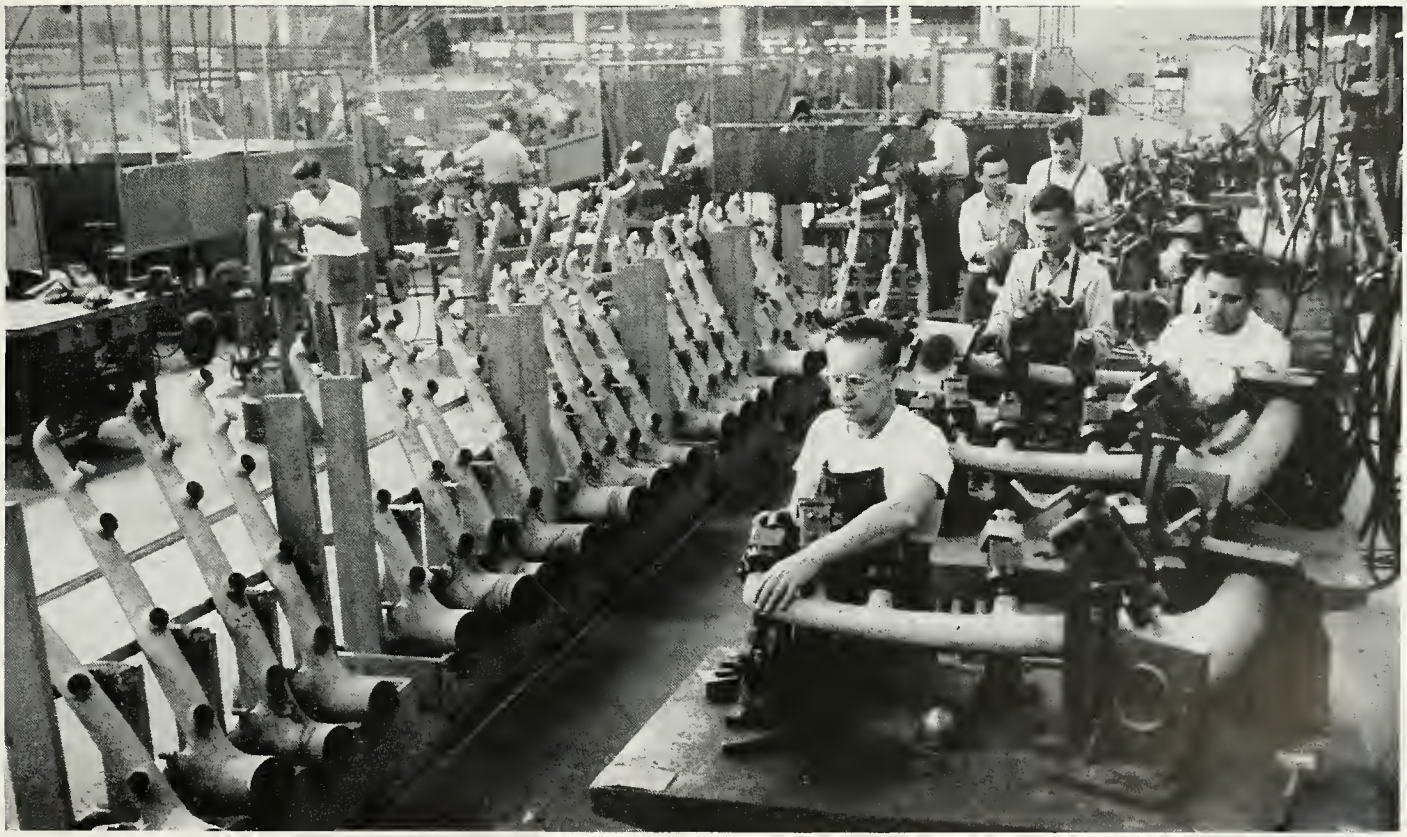
In assembly line methods, Ryan has produced large numbers of exhaust systems for Pratt & Whitney engines powering Stratofreighters.



KING OF THE HELIC

FROM a small single-rotor job to the world's largest transport helicopter, recently unveiled, has been a span of only 11 years for Piasecki Helicopter Corp.—a decade and a year that have revolutionized military and commercial thinking about the uses of rotary wing aircraft.

Perhaps more than any other company, Piasecki has boldly proclaimed the mission of the helicopter—first as a rescue instrument and now as a cargo and personnel carrier.

It is certain that Piasecki is the only major manufacturer engaged solely in the production of helicopters. And for its models turned out in large quantities, the HUP's and the current H-21's, Ryan has been the only supplier of high temperature exhaust systems and shrouds. For the experimental YH-16 Transporter, built for the Air Force as the world's largest helicopter, capable of carrying 40 troops, 32 litter patients or three jeeps, Ryan built the collectors for the two 1650 h.p. Pratt & Whitney R-2180 14-cylinder engines.

Ryan has built hundreds of exhaust systems for the Continental R-975, 525 h.p. engines used in the HUP helicopters. A mass production program is now getting under way to produce similar equipment for the 1425 h.p. Wright R-1820, 9-cylinder engines installed in the H-21 "Flying Bananas" (so-called because of their "bent" fuselage).

Because these radial, air-cooled engines are "buried" within the helicopter's structure, Ryan also builds stainless steel shroud systems which insulate the aircraft from the heat of the exhaust system. A number of these shrouds have been fabricated from titanium and demonstrated exceptional advantages under flight tests.

The YH-16 demonstrates how far we have progressed in acceptance of the helicopter as a tool of mass transportation. It weighs more than twice as much as the 20-passenger H-21 Work Horse, which is the largest helicopter in service today. Its fuselage, almost 78 feet long, is comparable to that of the Convair Liner. Including the rotor blades, the over-all length is 134 feet—28 feet longer than the DC-6 and 20 feet longer than the Super Constellation. For the first time in America, a twin-engine helicopter has been built with tandem-rotor design. The all-metal blades, 82 feet in diameter, form the largest shaft-driven rotors in the world.

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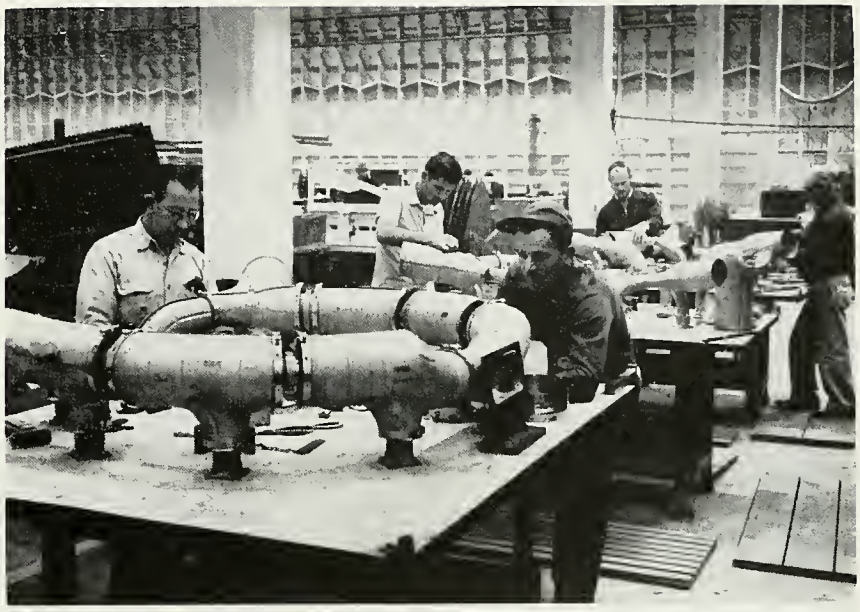
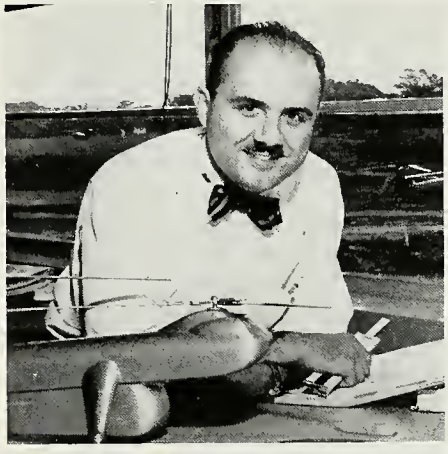


Ryan has been the sole supplier of high temperature exhaust systems and shrouds for the Piasecki HUP and current H-21 helicopters, produced in large quantities.

Piasecki's YH-16 Transporter, world's largest helicopter, climaxes 11 years' advance from small single-rotor craft

OPTERS



Frank N. Piasecki, founder of company bearing his name, foresees helicopters of great speed and tremendous lifting capacity. YH-16, shown above left, can carry 40 men, 32 litter patients, or 3 jeeps.

Under Piasecki's bold leadership, the helicopter has assumed a vital place in naval aviation and the Air Force, first as a rescue instrument and now also as a cargo and personnel carrier. Photo shows HUP operating off aircraft carrier.

Official U. S. Air Force Photo

"Elmer," a dummy constructed to simulate an average man, has been strapped to his rocket-propelled sled chair and is all set to take a fast ride to an abrupt halt on the Flight Test Center's deceleration track.

DESERT SEARCH

Strange things are happening in the Mojave Desert

IMAGINE a railroad track on which vehicles streak along at a 1000 mile per hour clip; a rocket engine test stand designed to anchor down half a million pounds of thrust; a mere human strapped in a sled-like contraption withstanding a bone-crushing impact of 45 times the weight of his own body!

The bizarre is commonplace at the Air Force Flight Test Center (AFFTC), located less than a hundred miles northeast of Los Angeles near the center of the Mojave Desert. Edwards Air Force Base is the place where, in their supersonic research craft, the world's top test pilots play a daily game of tag with the speed of sound. In fact, it was here that the sonic barrier was first pierced by Major Charles E. Yeager in the rocket-powered X-1, and it was here that civilian test pilot Bill Bridgeman flew the D-558-II Skyrocket to a height of better than 79,000 feet—"where I could see the curvature of the earth."

Hard as concrete and flat as a tabletop, Rogers Dry Lake provides a 65 square mile surface which is perfect for flight testing. Its broad expanse provides the distance needed for the take-off run of stubby-winged research aircraft, and

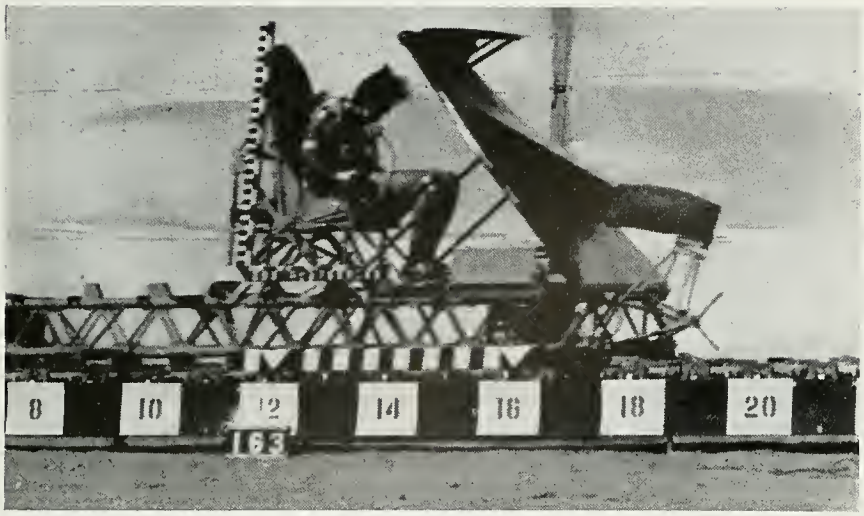
(Continued on Next Page)

Official U. S. Air Force Photo

Through an optical viewer, an engineer of the Experimental Rocket Engine Test Station observes the flame pattern of a rocket engine undergoing a test firing.

The concrete of the flame pit far below the huge static thrust stands is scorched by the fiery blast of exhaust from a rocket engine.

Official U. S. Air Force Photo

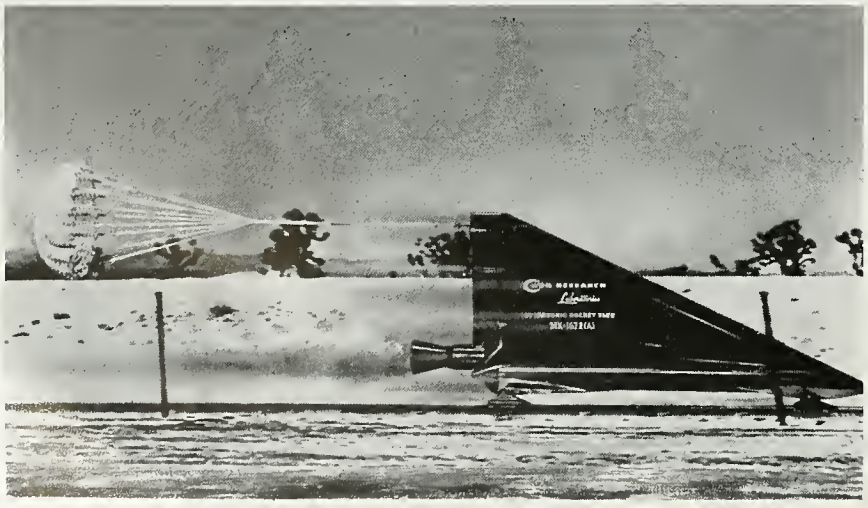


Strapped to his sled chair and wired for reactions, Lt. Col. Stapp streaks to a bone-crushing crash impact of 45 "Gs" during deceleration experiments at Edwards.

Official U. S. Air Force Photos

Air Force engineers inspect rocket sled prior to supersonic test run on the high speed track facility at Edwards Air Force Base, Edwards, Calif. The world's fastest earth-bound vehicle, the sled accelerates from a dead stop to 1,500 miles an hour in only five seconds. The sled is used to study performance of parachute equipment.

This sled, shown as it flashes along the 10,000 foot track, was designed by Cook Research Laboratories and is powered by a North American Aviation rocket motor.



there's plenty of room for high speed emergency dead-stick landings.

While by some standards the most spectacular, flight testing is not the only interesting and important role the AFFTC plays in this nation's research and development effort. Sprawled over 200,000 desert acres, its diverse facilities include a rocket engine test station where static thrust facilities are provided for testing of astronomically high-thrust guided missile rocket engines; a high speed track 10,000 feet long where supersonic sleds streak along at better than 1,000 miles per hour; and a 2000-foot deceleration track on which human volunteers are slammed into gut-wrenching braking systems to simulate "G" forces received in aircraft crashes.

Rearing from the sunbaked granite of Leuhman Ridge, some twenty miles east of the main base, are two gigantic structures resembling what might have been the monuments of some forgotten race. They are the huge cement and steel static thrust test stands of the Experimental Rocket Engine Test Station (ERETS).

As rocket engines have increased in size and complexity from early models of less than 1,000 pounds thrust to today's giants, it has become impractical and uneconomical to test rocket motors in free flight. The need for a facility capable of static testing missile propulsion systems, both the individual components and in entirety, became imperative.

The U. S. Air Force recognized this need in 1946 and decided to build and operate the stands for use by all civilian contractors. Primary motives behind such an arrangement are economy and efficiency. The Air Force reasoned that it would be much cheaper to build one completely equipped plant for use of all contracting agencies than to build (directly or indirectly at Government expense) separate, though less complete facilities for each.

The location at Edwards was chosen in 1947 because of the advantages of its proximity to a large industrial area (Los Angeles) and the isolation provided by the unpopulated Mojave Desert. This isolation is required because of the noise nuisance and psychological effects of engine tests, the danger of violent explosions and the toxic nature of missile propellants, such as nitric acid.

By far the most prominent structures of the Rocket Test Station are the huge test stands. Designed to withstand the strain of many thousands of pounds of thrust acting vertically, the structures are built on slopes with footings penetrating as deep as 60 feet into solid granite.

Missiles or rocket engines fit comfortably into the steel mounting cradles, and

(Continued on Page 22)

Solenoids are tested by blind William John Saiger, who connects them to a test panel, suspends ten-pound load, and throws switch to check lifting capability.

First totally blind Ryan employee succeeds in laboratory job

HE SEES WITH HIS INWARD EYES

WHEN William John Saiger was hired last April as the first and only totally blind employee of the Ryan Aeronautical Company, the step was frankly taken with considerable doubt whether such a handicapped person could adjust himself to full-time duties in an aircraft factory.

Today, almost a year later, Saiger has become such an accepted member of the Ryan family that his immediate superior, Win Alderson, assistant supervisor of the engineering laboratory, remarks:

"We never even think of Bill as being blind."

The 37-year old ex-serviceman was employed as a research laboratory analyst because he had considerable experience in the radio and electronics fields before he became blind in 1949. Virtually overnight he lost his eyesight while stationed at Fort Bliss, Tex. Atrophied nerves were believed the cause, but fierce battle action in World War II had levied its toll. A veteran of the Normandy invasion and seven campaigns in Germany, Belgium, France, Holland, Africa and Sicily, Saiger suffered shellburst concussions and other head injuries which contributed to his loss of vision.

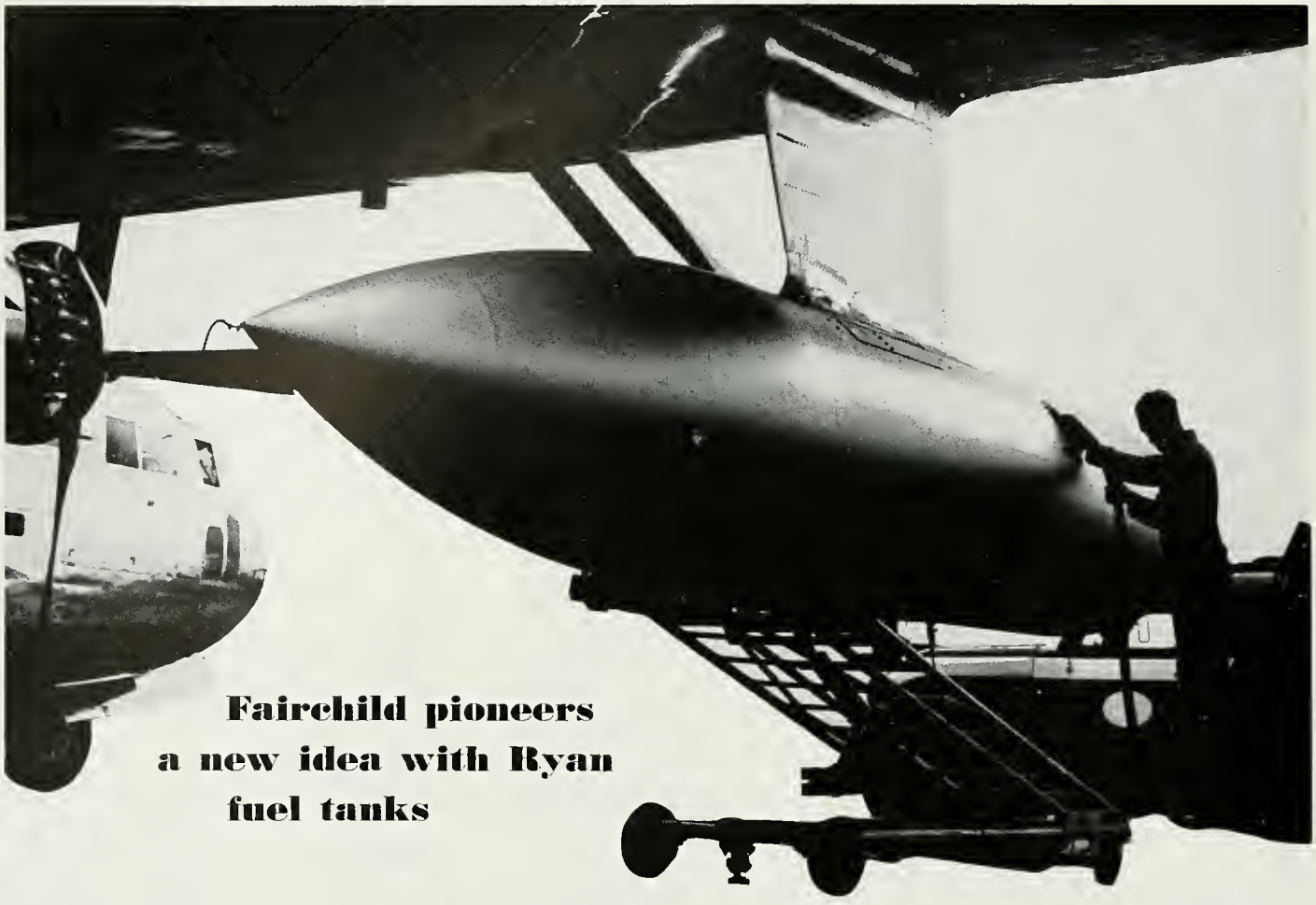
His rank of captain on retirement for disability in 1950 was won the hard way. He enlisted in 1936, and received two battlefield promotions for heroism, from sergeant to second lieutenant and then to first lieutenant.

After a period of medical treatment and attendance at Texas Western College, El Paso, and San Diego State College, Saiger took the initiative and sought a steady

(Continued on Page 26)

Saiger is adept at use of soldering iron in connecting plugs to cables of meters to measure thrust of pilotless planes.

A German shepherd guide dog accompanied Saiger to Ryan on his first day in the plant. Now he needs no such assistance.



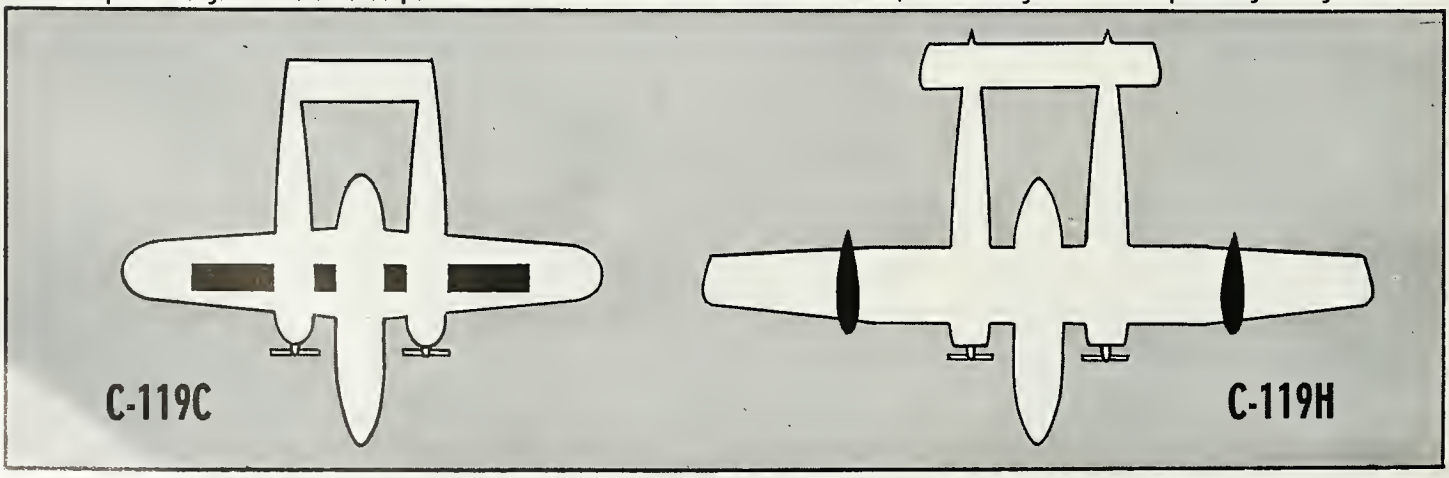
Fairchild pioneers a new idea with Ryan fuel tanks

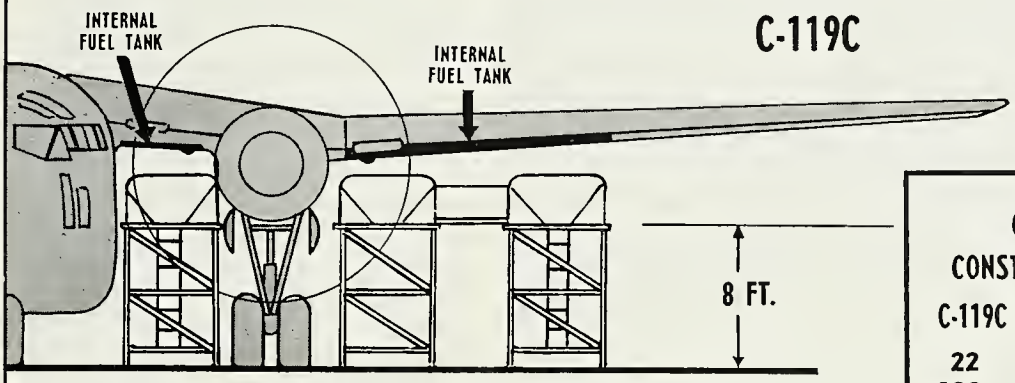
THE FUEL IS OUT

A FAMILIAR sight in the sky since F-80's first displayed their wing-tip tanks, external fuel containers have attracted little attention on aircraft. When Fairchild's new C-119H troop and cargo carrying transport made its maiden flight, observers casually noticed the two huge Ryan-built fuel cells suspended below its sturdy wings. However, their jaded nonchalance was shaken when they learned that the entire fuel supply of this new "Flying Boxcar" was carried in these external tanks.

Fairchild engineers had discovered several potent advantages for accomplishing this pioneering innovation. Long conceived as a means for packing extra fuel to extend range, external wing tanks have been given a significant new role in cargo aircraft which may overshadow their former importance.

Area exposed to gunfire is over 50 percent less when external fuel tanks are used, and leakage cannot seep through wing sections.

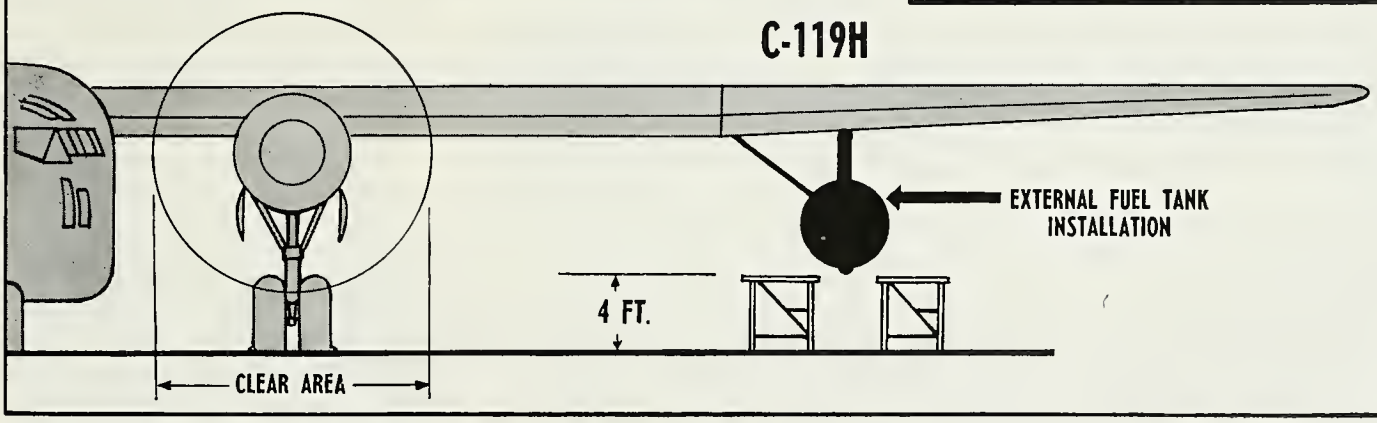




External fuel advantages are graphically shown in this sketch. Over 200 parts, weighing 800 pounds, are eliminated by simpler structure. Another 1200 pounds is saved in combat models carrying self-sealing fuel tanks. Fire hazards are cut by fuel's remoteness from ignition sources. Tanks can be dropped before crash landings or are knocked clear upon impact. Maintenance men will welcome tank's easy reach which permits use of trucks or 4-foot stands instead of 8-foot types. Refueling is faster because both tanks can be fueled at once and are filled while engines are running. These benefits mean less service needs, more safety and dependability and a faster turn-around time.

GREATER SIMPLICITY IN CONSTRUCTION AND MAINTENANCE

C-119C		C-119H
22	Tanks	2
132	"V" Boards	0
7	Valves	3
4	Pumps	2
6	Gages	4
5	Controls	3
90	Interconnects	0
4	Fillers	2
10	Access Doors	0
4	Pump Sump Drains	2
6	Maintenance Stands	4



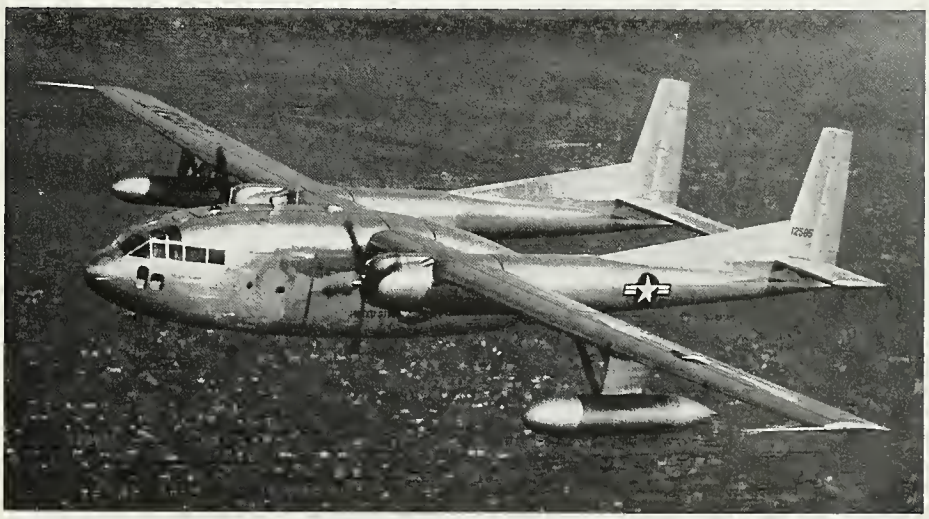
When designers elect to carry the entire fuel supply in external wing tanks, six major benefits are derived. These are: improvements in (1) simplicity, (2) weight saving, (3) cargo facility, (4) safety, (5) refueling and (6) service and maintenance.

Although these advantages are realized in the design of a transport plane, such as the C-119H, they also have important implications for other types of aircraft. Many American authorities advocate podded jet engines suspended beneath the wings of high speed aircraft. A number of their reasons for espousing this type of power plant installation, apply to the concept of fuel carriage which Fairchild has introduced.

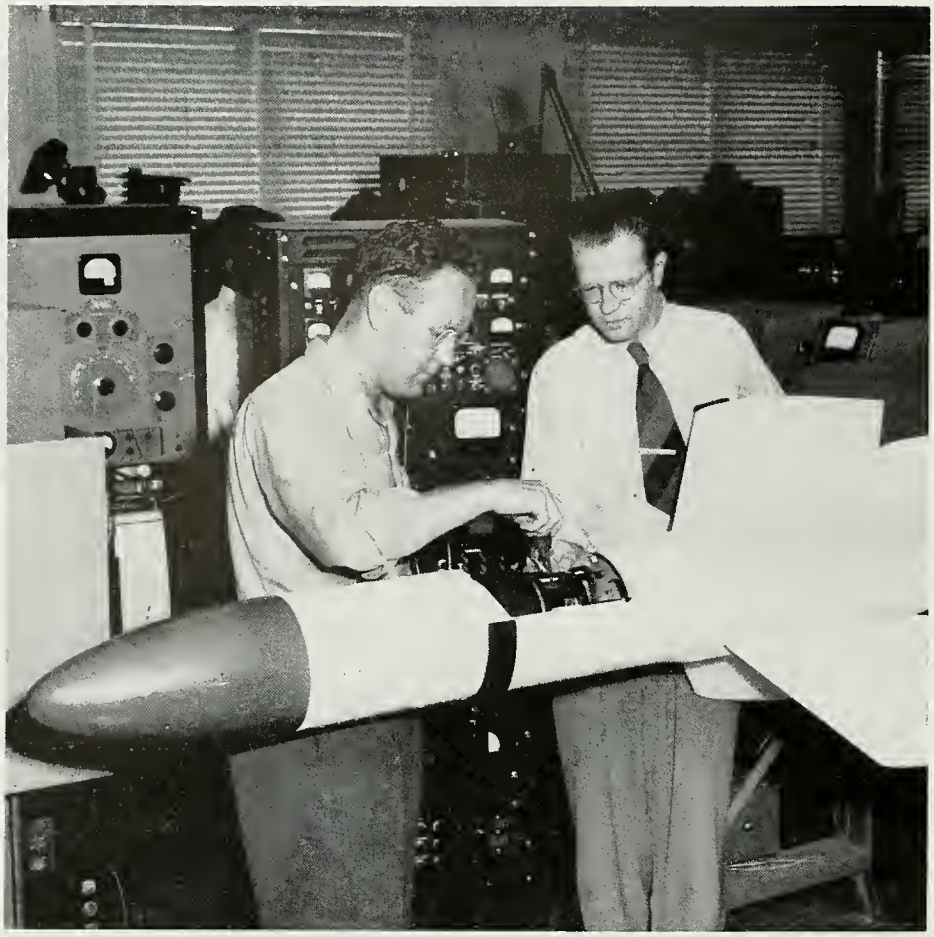
SIMPLICITY

Immediate benefits in simplicity of structure are gleaned by switching fuel supply from wing and fuselage tanks to

(Continued on Page 19)



New, enlarged version of Fairchild's famous "flying boxcar" transports is the C-119H which has greater range and capacity. Plane can drop troops and cargo with unerring accuracy. Unique feature is stowage of all fuel in external tanks built by Ryan.



Electronic components must be subminiaturized to fit into the amazingly small space provided for them aboard today's aircraft and missile. Here Ryan engineers, R. F. Chadwick and R. J. Cary, Jr., make adjustment on a device in an air-to-air missile.

ELECTRONS at WORK

The tiniest particles of matter perform giant-sized tasks

THE multi-faceted science of electronics is rapidly becoming the fastest growing segment of the modern aircraft industry. Indeed, electronics and aircraft are inseparable—the success of our military air operations depends to a large extent upon the satisfactory operation of electronic devices and their thousands of associated components and parts.

Ryan is keeping pace with the technological advances in this fruitful field of development. Through electronics research, Ryan engineers are developing guidance systems for missiles and airborne navigational devices for both piloted and pilotless aircraft. The components of these systems are telescoped into amazingly small packages to meet the ever present problem of limited space aboard advanced-type aircraft and missiles.

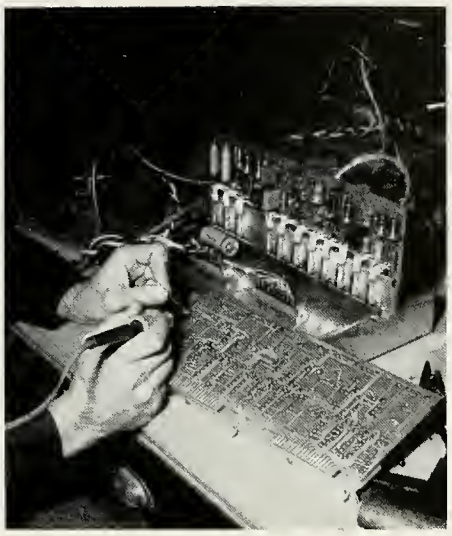
Electronics has already altered and now promises to completely reshape the techniques of aerial warfare. Electronics equipment alone accounts for nearly half the cost of a modern jet bomber. Nothing has had a greater impact upon military aviation since the first World War when Fokker's development of the synchronized machine gun first made air warfare a reality.

For all practical purposes, the first device in the field of aviation which could be termed "electronic" was the airplane air-to-ground radio. This six tube affair, the great granddaddy of the hosts of electronic devices in use today, was first installed and successfully tested in an airplane in 1915.

Ryan electronic engineers climb aboard a Navy twin-engined P2V Neptune to conduct in-flight evaluation of Ryan equipment. Plane was loaned to Ryan for this purpose.

Today's Goliath of the skies, the B-36, contains more than 2,000 vacuum tubes and thousands of electronic components which perform a multitude of vital tasks from the moment of take-off until the final touchdown. These devices provide airplane stabilization, are used to navigate, to detect and shoot down enemy fighters, to aim and guide the bomb to its target, and to bring the huge aircraft in for a landing in any kind of weather.

In the not too distant future, interceptors will be automatically controlled by electronic devices once the aircraft is airborne. Ground-based radar will automatically direct the plane to the vicinity of the target, then the interceptor's own



An experimental "etched" circuit plug-in assembly is modified by an engineer.

H. J. Puterbaugh measures performance characteristics of an electronic unit.

J. D. Roberson and F. D. Russell wire control panel for electronic computer.

radar fire-control system will take over to put it on the proper attack course.

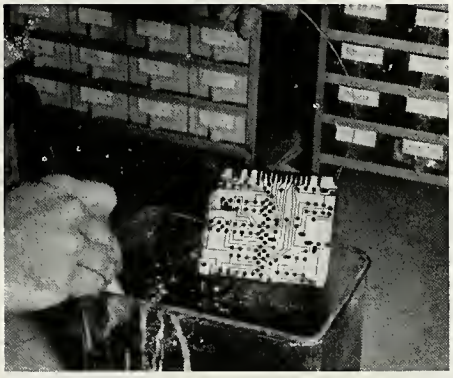
Once the target is within firing range, the electronic equipment will aim and fire the weapons, and maneuver the interceptor to avoid collision with the target. Electronic equipment will then automatically fly the interceptor to its home base and set up a landing pattern. The pilot will take over only in the final moments of the landing.

From this example, it is obvious that electronic devices are capable of simulating something akin to the human process of communication and control. Radar provides the eyes, radio the ears, computers provide the brains and servo mechanisms the muscles. However, the human pilot, despite his inherent limitations, has not been entirely replaced, nor will he be in the near future. His most important contribution to the system is his ability to reason and correct a wrong trend or event, should it occur.

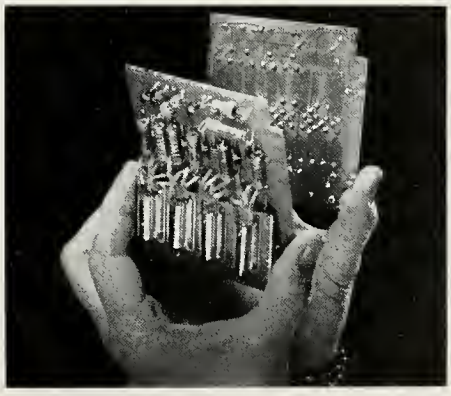
The heart of the various electronic devices that accomplish these seeming won-

(Continued on Page 27)

Acid solution etches away the unwanted copper, leaving only the wire pattern.

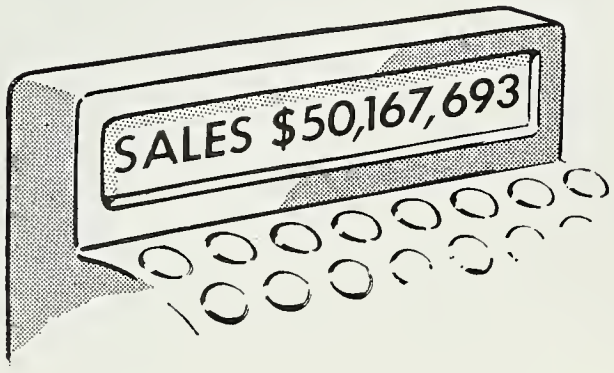


Mirror shows both sides of subminiature assembly with the "etched" wire circuit.



The field testing of experimental radar equipment is conducted from the Ryan mobile field test laboratory against an actual aircraft target at Edwards Air Force Base.

CHECKING ON RYAN'S



Company earnings were the best

expenses still took more than

THE financial results of anyone's work are measured by the difference between his income and what he spent during the year. The same is true of a business. When outgo exceeds income the results are disastrous. When a company's income exceeds outgo the results are beneficial for its employees, owners and customers.

That is why it is important for everyone connected with Ryan to be familiar with the financial condition of the company—to see what was taken in last year and how that money was spent.

On the cash register above is recorded the fact that Ryan's gross income for the 1953 fiscal year was $50,167,693. This was the second highest business revenue in the corporation's 23 years of operation, being exceeded only by the peak production of World War II when total business was over $55 million in 1945.

The principal types of work contributing to sales were the production of jet engine components, exhaust system for piston engines, complete rocket motors, large airframe assemblies, aircraft of the company's own design, and engineering and development of aircraft and aeronautical products on prime contracts from the military services.

Now that both the amount of business done last year, and the various activities of the company which contributed to the total sales have been recorded, it is well to see how that money was spent and who benefited by the large volume of work done.

In its day-to-day operation the company issues somewhat over a quarter of a million checks each year. For this report that number has been condensed to just six "checks" but they cover every dollar spent in 1953. As you look at these checks it is interesting to see how much of the money received went to the employees of the Ryan Aeronautical Co. in wages, salaries and benefits, as well as the large sums which are paid to suppliers. In addition, one of the largest "checks" written each year is to federal, state and local government.

to all Ryan employees, the company made other substantial payments for such items as sick pay, unemployment insurance tax, workmen's compensation, paid vacations, holiday pay, group insurance, rest periods and social security. As one of the large employers in San Diego, Ryan's $19,406,322 payroll was, for the most part, spent here for homes and furniture, education, television sets, insurance, food and clothing, and thus added to the high level of business activity and standard of living in San Diego.

NO. 1 The Year 1953

THE NATIONAL BANK

PAY TO Ryan Employees $19,406,322.

nineteen million four hundred and six thousand three hundred and twenty two DOLLARS

FOR Wages, Salaries + Employee Benefits

Ryan Aeronautical Company

WAGES AND SALARIES

The wages and salaries paid to Ryan employees last year took 39 cents of every dollar the company received from its customers. The average number of employees on the payroll during the year from October 31, 1952 to October 31, 1953 was 4250. The annual pay of the average employee was $4567. Payrolls amounted to nearly $75,000 per working day.

In addition to the wages paid directly

MATERIALS AND SUPPLIES

Out of every dollar taken in by the company 47 cents was needed to purchase the materials and supplies used in making the products we sold our customers. In the course of the past year the company spent $23,657,671 for materials and services and for miscellaneous other expenses. This provided supplies worth approximately $5500 for each employee to process in keeping the production lines rolling.

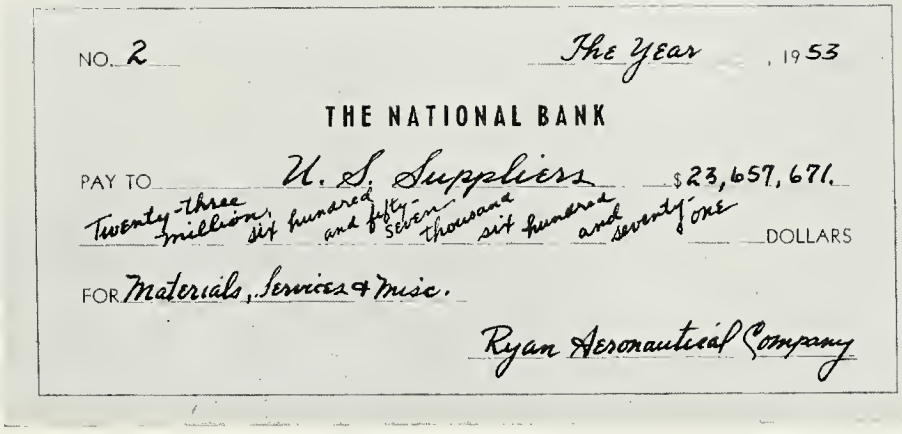
BUSINESS LAST YEAR

ver, but wages, supplies, taxes and other

7c of every $1.00 taken in during 1953 fiscal year

The greater part of the $23½ million spent was paid by Ryan to a broad cross section of industry which furnishes materials such as steel, aluminum, sub-contracted parts built in other plants, welding rod, safety glasses, forgings, etc. and services such as heat, lights, gas, printing, telephone and the many other daily needs.

The money for materials is spent in practically every state and helps to make better business and more jobs in every section of the country. Wherever possible the goods and services are bought from local firms and contribute to the welfare and prosperity of the San Diego area.


NO. 2 The Year , 1953

THE NATIONAL BANK

PAY TO U. S. Suppliers $23,657,671.

Twenty-three million, six hundred and fifty-seven thousand six hundred and seventy one DOLLARS

FOR Materials, Services & Misc.

Ryan Aeronautical Company

TAXES

To carry its share of the expenses of federal, state and local governments, Ryan Aeronautical Co. paid out the equivalent of $1,210 or $100 per month in taxes for every employee on the payroll last year. This did not include withholding taxes from employees pay. Most of the taxes, except income taxes, have to be paid regardless of whether or not the company makes a profit.

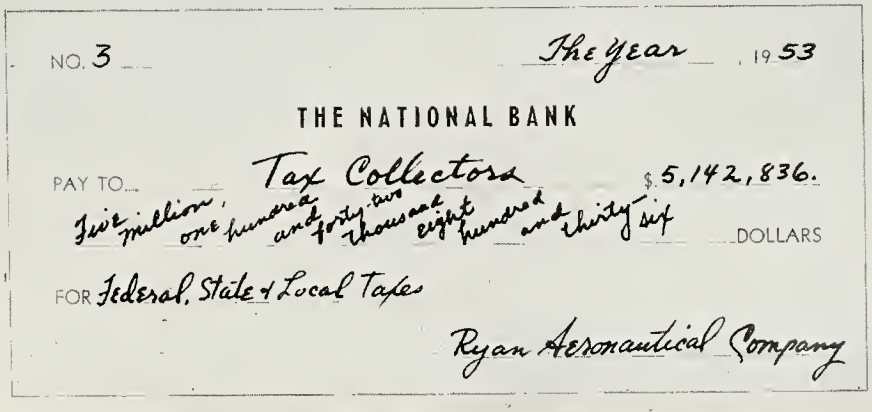
In the role of tax collector, Ryan last year transmitted to federal, state and local governments $5,142,836 which we, in turn, had received from our customers. These taxes are spent for the support and services of the government— national defense, public safety, schools, hospitals, farm subsidies, "free" education and medical services etc. But nothing which comes from the government is in fact "free." Taxes collected from the people are the government's only source of revenue. The people . . . you and me—employees, customers, suppliers, owners—must foot all the bills of government.

DEPRECIATION

Into the fund which accountants call depreciation the company paid $556,960 during the year. This is a fund set aside to provide for the replacement of the tools of production—by which we mean each and every machine and building we have.

The tax laws allow the company to set aside only amounts based on original cost. But with prices the way they are today, regular depreciation allowances are sufficient to take care of only about half of replacement requirements. If Ryan should limit its replacements, year by year, to the amount of its allowed depreciation, its plant would get smaller and smaller and would wind up having far less equipment than it started with. Fortunately, the stockholders have indicated a willingness to make up the difference needed to

(Continued on Page 18)


NO. 3 The Year , 1953

THE NATIONAL BANK

PAY TO Tax Collectors $5,142,836.

Five million, one hundred and forty-two thousand eight hundred and thirty six DOLLARS

FOR Federal, State & Local Taxes

Ryan Aeronautical Company

CHECKING ON RYAN'S BUSINESS LAST YEAR

(Continued from Page 17)

replace worn out machines and buildings by providing for new equipment out of their so-called "profits."

DIVIDENDS

When the four biggest bills were paid last year, the $50 million taken in had dwindled to $1,475,446, which is the figure accountants call net profit. This amounted to a profit of less than 3 cents on every dollar of business; and most of this went right back into the business.

The Ryan Aeronautical Company is owned not by a few individuals but by over 1000 separate investors. All of these people have invested some of their savings with Ryan as an expression of their faith that the company will remain a going concern. With the money they originally provided, and what they have re-invested over the years, the company was able to get started and has since continued to grow. Without the help of the stockholder-owners there wouldn't be a Ryan Company as it is known today. Ask anyone who has tried to start a business without enough capital to make the grade.

In return for investing their money, the company last year paid its stockholders 50 cents a share, the same as was paid them in 1951 and 1952. The total paid the owners was $195,729. This cash dividend is more properly called the "rent" money paid the owners for use of the tools, buildings and money that they provide for the operation of the business.

It is interesting to note that while stockholders receive cash dividends of 50 cents a share, the tax bill amounted to $13.23 a share. Thus it may be seen that government—particularly the federal government through its regular and excess profits taxes on corporations—has a very real interest in seeing that the company operates efficiently and successfully. Without taxes from the profits of Ryan and thousands of other corporations, the government would have to levy income taxes on individual citizens nearly double what they are now.

NO. 4 The Year 1953

THE NATIONAL BANK

PAY TO U. S. Equipment & Building Co. $ 556,960.

Five hundred and fifty-six thousand nine hundred and sixty DOLLARS

FOR Replacing Machinery and Buildings

Ryan Aeronautical Company

NO. 5 The year 1953

THE NATIONAL BANK

PAY TO Ryan Stockholders $ 195,729.

One hundred and ninety-five thousand seven hundred and twenty-nine DOLLARS

FOR "Rent" on Owners' Investment

Ryan Aeronautical Company

NO. 6 The Year 1953

THE NATIONAL BANK

PAY TO A Stronger Ryan Company $ 1,204,039.

One million, two hundred and four thousand and thirty-nine DOLLARS

FOR Future Job and Business Security

Ryan Aeronautical Company

RE-INVESTMENT

After writing the fifth "check" to the owners to cover their dividends, $1,204,039 was left and re-invested in the business to meet increased working capital requirements and for the purchase of the additional machinery and plant equipment needed to maintain and improve the company's hard won position in the highly competitive aeronautical industry. It may be difficult for some to see how the re-investment of this money goes to make a stronger Ryan organization. Although it is not indicated on the final one of our checks, it is quite apparent that employees share in it because a stronger Ryan means inevitably a company with a better chance to serve its customers and so provide better security in the future, not only for the owners but also for Ryan's 4,000 employees.

THE FUEL IS OUT

(Continued from Page 13)

underwing containers. In the Fairchild C-119H transport, the two Ryan-built tanks replace 22 individually-tailored fuel containers carried within the wings of the C-119C model. More than 200 parts, including valves, pumps, interconnects, gauges, fittings and access panels are eliminated and plumbing requirements are cut to one third. By clearing the internal wings of fuel cells, a straight-through center section of more economic design can be used.

WEIGHT REDUCTION

The simplification of structure provides a welcome 800-pound weight saving premium to the designer. An additional 1600 pounds of weight is saved through the deletion of self-sealing fuel cells. For the small fraction of C-119H's which must operate in combat zones, a self-sealing blanket, weighing less than 400 pounds, can be easily installed in the field. This facility permits the balance of the aircraft to operate without the handicap of weight imposed by internally-sealed fuel cells. Against the 2000 pounds, or more, weight saved must be charged some extra fuel required because of the added drag of the tanks in flight.

SAFETY

External fuel is ideal from a safety standpoint. All fuel except a 30-minute reserve supply in the sump is jettisonable within a few seconds. This greatly decreases the hazard of fire in crash landings because the pilot can elect to drop his tanks prior to landing. It also enhances the single engine performance of the aircraft, substantially and instantly, by reducing weight in case of an engine failure.

In instances of leakage, fuel cannot seep through wing and fuselage structures or contact ignition sources. In case of fire, the extent of damage is minimized or eliminated by the remote location of the fuel. In combat use, the system offers appreciable advantages because the area exposed to ground fire is more than 50 percent less than with internal tanks.

CARGO FACILITY

Aerodynamically, underwing fuel tanks detract slightly from the speed of the C-119H due to drag. But this reduction is not an important factor in the mission of a cargo and troop-carrying plane. And, it is more than off-set by the stepped up cargo handling facility which underwing tanks provide.

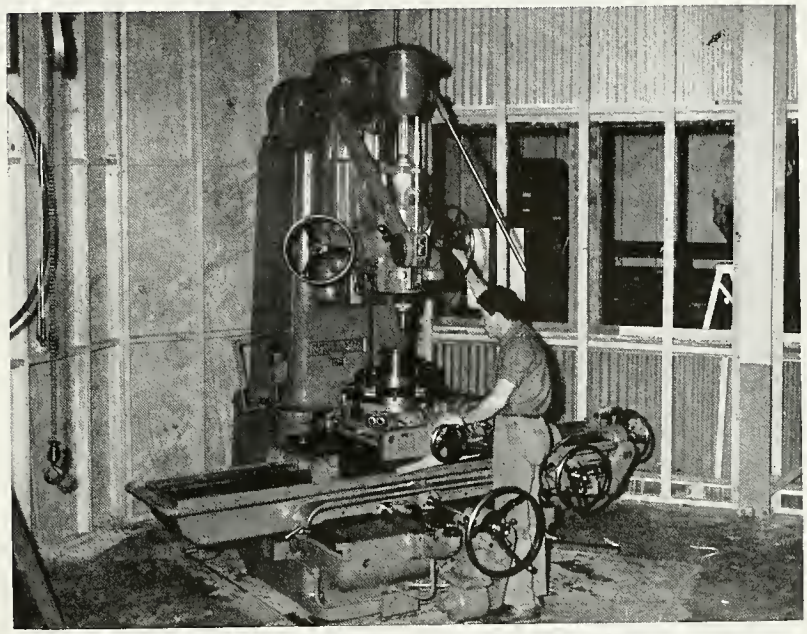
Medium size transports, such as the C-119H, are required not only to carry substantial loads over extended ranges but they must also be capable of dropping their troops and cargo with bull's-eye accuracy. Just as a bomber must make a direct hit to destroy a bridge, so must a military cargo-carrier deliver a new bridge section by parachuting it to the river bank and not into the river or far from it. To do this, the aircraft must have good low speed characteristics and stability. These are more important than high speed performance.

One of the limiting factors in dropping heavy deliveries, such as large calibre guns or bridge sections, is the difficulty in maintaining aerodynamic control as the center of gravity shifts rearward during the extraction process. Underwing fuel tanks widen the fore-and-aft limits within which cargo may be carried and shifted because they place the fuel weight exactly under the aerodynamic center of the airplane and it remains there throughout the flight. This speeds up loading operations, to cut turn-around time, and permits use of less experienced personnel.

REFUELING AND MAINTENANCE

Underwing fuel tanks permit two-point refueling, one filler in each tank, which is much simpler than single-point refueling of wing tanks. Fillers are accessible from the rear bumper of fuel trucks. Engines can be left running or checked during refueling.

Inspection and maintenance of fuel tanks is also facilitated since the cells are suspended in the open without the need for removing access doors, wing skins and other obstructing structures. Less pump sump drains, fillers and maintenance stands are needed in connection with the underwing installations. Four maintenance stands only four feet high can be used instead of the six eight-feet high stands which were formerly required. These advantages cut overhaul, inspection and maintenance operations to the minimum.



DUST PROOF—Jack Noble operates sensitive new Pratt & Whitney jig borer while walls for dust proof room are built around high precision machine.

Dust-Proof Room Constructed To Protect Sensitive Machine Tool

Installation of the most sensitive machine in the tooling department has made it necessary to build a dust-proof room at the northwest corner of the main factory building.

The tool is a giant Pratt & Whitney jig borer, which drills holes to such close tolerances that the least amount of dust would affect its precision. In its program of obtaining the most modern equipment available, Ryan spent approximately $37,000 for the machine and the rotary table used with it.

Air is introduced into the room through a filtered intake, and constant air pressure is maintained, so that when a door is opened, air will escape rather than enter with dust particles. The room is about 18 by 24 feet.

Also installed in the room is a Clearman jig borer, which has been in use in the plant for several years. The Pratt & Whitney machine was built in West Hartford, Conn. by the company whose major activity is production of aircraft engines.

THE AFTERBURNER STORY

(Continued from Page 3)

April 25, 1946. The engine used was the General Electric I-16 which was also the jet power plant for the composite-engined Ryan FR-1 Fireball fighter—the Navy's first plane to have a jet engine.

During this period, the large aircraft engine manufacturers were concentrating their talents on basic turbojet designs. They soon brought their resources to bear on afterburner problems. They have undoubtedly contributed most to the present models of these thrust-boosting mechanisms by developing currently-used designs through their engineering staffs.

Afterburning is such an old idea that it is impossible to know who first thought of it. Among engineers, afterburning is more accurately known as "reheating." In England, the afterburner is called a reheat engine. Reheating is defined as "appreciably improving the efficiency of an engine by reheating the working fluid after it has partially flowed through the engine." Actually, afterburning is a well known thermodynamic technique, capitalized upon by hordes of inventors, and stretching back almost to the very first heat engine devised.

Not long after James Watt produced the first practical steam engine in 1764, reheating was incorporated into its design. The steam was reheated between expansions in the cylinders in order to extract more mechanical energy from it. The same strategy was resorted to after Sir Charles Parsons introduced his commercially successful steam turbine in 1884. Reheating has been universally used as a means for increasing steam turbine power plant efficiency by adding heat to the steam after it has partially flowed through the engine.

Sir Frank Whittle, of England, described the same principle in the "dual thermal cycle" engine which he patented in 1936. This device employed a diesel engine and compressor to supply air and combustion products to a turbine which drove the main compressor. The turbine exhaust was used to obtain jet propulsive effects. Whittle proposed "adding heat to the turbine exhaust before final expansion in order to provide further thrust for carrying temporary overloads."

On August 27, 1940, an all-metal monoplane designed by the Italian engineer, S. Campini of the Caproni Company, made a ten-minute flight from Forlanini airport in Milan. With the possible exception of German man-carrying, rocket-propelled vehicles, this was the first plane to accomplish jet propelled flight. Campini used a piston engine, probably a radial Isotta Fraschini, to power a compressor which supplied air to the combustion chambers of his jet engine. In his plans for later versions of this aircraft and engine, he envisaged the advantages of burning fuel in the tail-pipe to attain increased thrust.

In 1940, Sir Frank Whittle produced the first successful turbojet power plant. The design employed an air compressor, powered by an integral gas turbine which is driven by the exhaust gases from the combustion chambers. In his achievement, Whittle drew heavily upon the accomplishments of others who preceded him. These included Englishman John Barber, who patented the first gas turbine in 1791, Sir Charles Parsons, developer of the axial flow compressor, America's Dr. Sanford Moss, who built the first turbosupercharger at General Electric, Swiss Dr. Adolph Meyer who produced the first modern gas turbine in 1930 and many others.

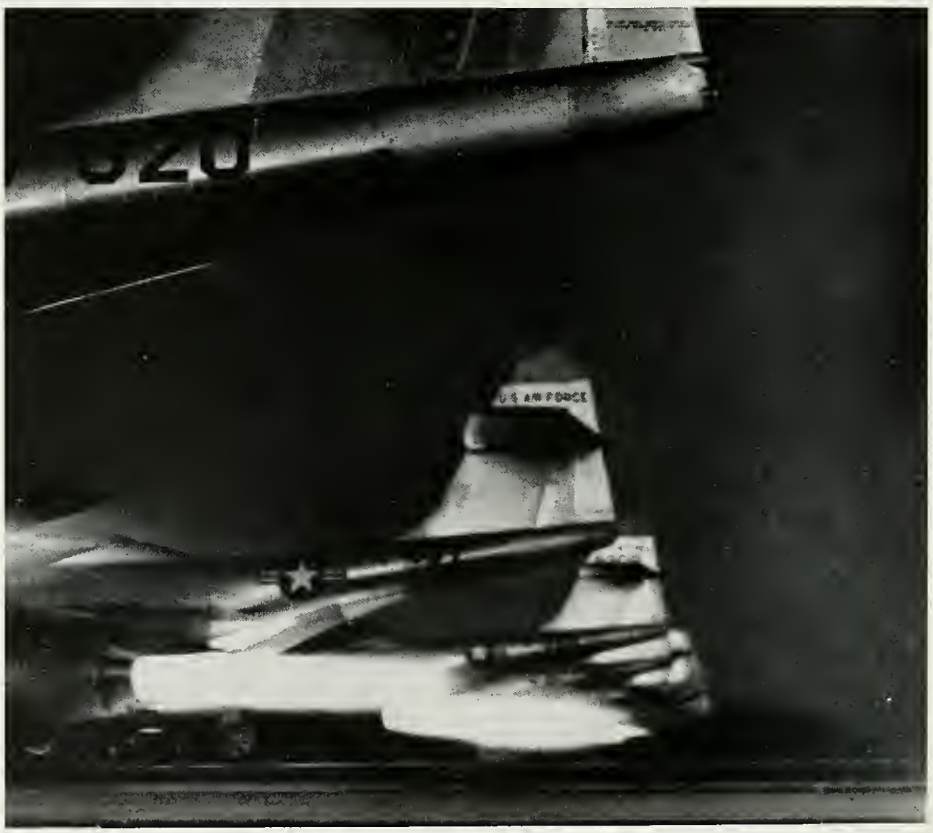
In 1908, the French engineer, Lorin, unveiled an original design employing a reciprocating engine which exhausted through a discharge funnel to produce propulsive reaction. His device encompassed the three basic requirements of a thermal jet engine: means for compressing air, adding heat, and expanding the resultant gas-air mixture.

The American inventor, Lake, patented a thrust augmentor in 1909 which demonstrated the aspirating effect of speeding exhaust gases and the added propulsive thrust obtained by this form of augmentation. These, and many other discoveries were important contributors to Whittle's solid achievement.

Another factor influenced Whittle's success. Many previous attempts to construct a successful gas turbine failed because it was not possible to operate at temperatures high enough to develop more than enough power to run the air compressor alone. Metallurgical advances overcame these obstacles to pave the way for the Whittle engine.

Under the cloak of wartime secrecy, the Whittle engine was flown to the United States and taken to the General Electric Company. Primarily because of Dr. Sanford Moss' work with the turbosupercharger, which involves a number of problems similar to those encountered in jet engines, General Electric was commissioned to build the first American turbojets.

In 1944, the NACA began work on the first U. S. afterburner, using General Electric's first turbojet engine, the I-A, as a power plant. Afterburning was contemplated as an effective means for augmenting thrust. There was more reason to use a reheat cycle in connection with turbo-



With tongues of flame lashing from their twin afterburners, Northrop F-89 Scorpion interceptors prepare for a night sortie. Afterburners provide a "double dose of benzedrine" for boosting these planes above 45,000 feet to unleash rocket salvos.

jets than with steam turbines because the technique imposed no additional temperature or centrifugal stresses upon the engine's vital components. Heat energy was added to convert pressure to velocity in order to obtain greater thrust.

In the NACA's first model, it is interesting to note that the basic requirements of efficient diffusion from turbine outlet to burner inlet, proper fuel preparation, and flame shelter, or holding regions, were recognized. Although combustion was successfully initiated, internal losses were so high and combustion efficiency so low that the maximum thrust realized was only 100 pounds.

In 1945, a blower rig was established in which afterburner inlet conditions were simulated by forcing air through a preheater, inlet diffuser and afterburner by a blower system. Numerous designs were tested in this rig, leading to the configuration which was tested with the General Electric TG-180 engine in 1946. A thrust increase of 40 percent was obtained.

The first altitude wind tunnel tests of afterburners were made in NACA's laboratory in 1946. These were begun with an afterburner-equipped TG-180. A number of configurations were investigated and successful operation was accomplished at 30,000 feet altitude with increases of thrust of over 100 percent at high simulated Mach numbers.

In 1947 and 1948, work on fuel systems, flame holders and exhaust nozzles was continued in the altitude wind tunnel and on static test stands. In these tests, the widely used fuel-spray bar system and familiar V-gutter flame holder design was developed. Since 1948, NACA has continued to pursue experimental research on afterburners in expanded facilities.

During 1944, Ryan launched a company-sponsored confidential research project to develop a successful ramjet combustion chamber for use with helicopter rotor blades. In this work, Ryan engineers constructed experimental combustion chambers and tested them by burning fuel within them in a high velocity stream of air. The chambers were fired on a test stand which measured the reactive thrust developed.

Essentially, a ramjet is a compressorless jet engine which involves the same problems of igniting fuel in a high velocity air flow, maintaining combustion and developing thrust that are found in the afterburner. At the conclusion of the ramjet combustion chamber work, in 1944, Ryan submitted a report which attracted the favorable attention of the Navy's Bureau of Aeronautics. The report pointed out the advantages which might be gained by using the thrust augmentation technique with the General Electric I-16 engine which Ryan was then installing in FR-1 Fireball fighters for the Navy. In response, the Navy awarded Ryan a contract to develop what was to be the first commercially-built afterburner in the United States.

Under the direction of engineer Dan Sanborn, Ryan started this work with data gleaned from the ramjet evaluations plus manufacturing experience obtained in building tail-pipes, and other high temperature components, for the jet-propelled Fireballs. Early Ryan afterburner models employed a fixed nozzle arrangement. This was soon changed to an adjustable type. Ryan was first to develop the "eyelid" type of variable nozzle, widely used today, as the practical means for controlling the exit area of the afterburner. Early Ryan photographs show the original examples of this type of adjustable nozzle which maintains a balanced flow of gas through the system when the afterburner is operating or dormant.

Because metals then available were inadequate for sustaining the extreme temperatures which afterburning imposed, Ryan engineers devised a regenerative fuel system for the afterburner. By circulating the fuel around the afterburner, prior to its combustion, the afterburner walls were cooled and the fuel was preheated so that it burned more efficiently. Although this innovation has not been carried forth into present day afterburners, it has been used to good avail in rocket and ramjet engine designs.

During this period, Ryan tested various types of ignition systems and fuel injection arrangements, measured the extreme temperatures encountered in the afterburner flames and evaluated high temperature alloys for these tortuous applications. This work outlined the extremely sensitive relationship between the temperatures, pressures and velocities in afterburner operation. It showed that the afterburner and turbojet must be designed as an integral unit if high performance is to be realized.

It is significant that when security restrictions were eased, Ryan was the first company to release "the afterburner story." In a five-page story, illustrated with diagramatic sketches, Ryan gave the public the first military-approved information on the afterburner, its function and advantages for aviation.

Since those days, afterburning has come a long way. And, the organizations which have brought it along are the companies who build turbojet power plants and jet components. To produce afterburners in quantity, the prime engine manufacturers have turned to Ryan — which combines intimate knowledge of afterburner development and engineering with long experience as a leader in production of high-temperature components for piston and rocket, as well as jet, engines.

Afterburning is an old idea. Countless inventors and engineers have contributed knowledge to this idea. But, today's afterburners are successful because highly trained staffs of engineers, working in companies like General Electric, Westinghouse, Wright Aeronautical, Pratt and Whitney Aircraft and Allison, have taken this heritage, integrated it with modern science and further developed this remarkable structure.

Noted Air Force Engineer Named Chief Designer

Col. Paul H. Kemmer, USAF ret., who helped develop virtually every well known Air Force plane through World War II as one of the key men in engineering activities at Wright Field, has been appointed to the newly created post of chief designer in the Ryan engineering division.

P. H. Kemmer

He will guide the broad design aspects of engineering projects and will originate long range plans for future technical activities under Bruce Smith, director of engineering.

A pioneer in aviation, he began his career as a flying cadet in the aviation section of the Signal Corps in 1917 after studying mechanical engineering at the University of Michigan. He won his wings in March, 1919, and for two years was in civilian life as a draftsman and designer for the old Winton and Packard motor car companies, the Dayton Wright airplane company, and Westinghouse. After service as a civilian aeronautical designer at McCook Field, Ohio, he returned to active duty in 1921 and rose to colonel in 1942. He retired Jan. 31, 1949.

Much of his military activity dealt with research, development and engineering to improve aeronautical equipment. The Air Corps assigned him to New York University, the Air Corps Engineering School, and the California Institute of Technology, where he received the master of science degree in aeronautical engineering in 1933.

Since retirement from the Air Force, he has been an aeronautical consultant with private firms, most recently with Owens-Corning Fiberglas Corp. in connection with the use of fiberglass-reinforced plastics for aircraft construction.

DESERT SEARCH

(Continued from Page 10)

during a test the flames from the engines drive vertically into the flame pit over a hundred feet below. To prevent damage to the cement by the extremely hot blast of large rocket engines, a water deluge system is installed which floods the base of the stand with a cooling 4000-gallon-per-minute stream of water. A similar system, built into the test stand itself, drenches the entire stand with jets and sprays of water in case of fire.

The nerve center during actual tests is the central control station, located midway between the test stands. From the control station, protected by steel doors at right angles, thick concrete walls and tiny windows with steel blast shields, engineers control the firing and runs of the engines mounted on the test stands.

In addition to windows, six periscopes are used to observe test firings being conducted on either stand. In the near future it is anticipated that television will be installed for direct observation of firings and the flame patterns.

In an effort to increase the efficiency of the stands, provision is made for mounting more than one engine on each stand at the same time. Although the engines are not normally operated simultaneously, this arrangement cuts the time lag between tests. Right now, most of the time on the stand is spent preparing for the actual firing, which may last from a few seconds to about a minute. Hours of preparation precede even the shortest firing.

The ERETS is still expanding with construction soon to begin on an assist take-off stand which will be used to check out Rocket Assist Take-Off units for planes in four bays at once. In the future, the two big test stands will be joined by a third, and a hydro-dynamics laboratory will be erected for the upkeep of the stand fluid handling equipment.

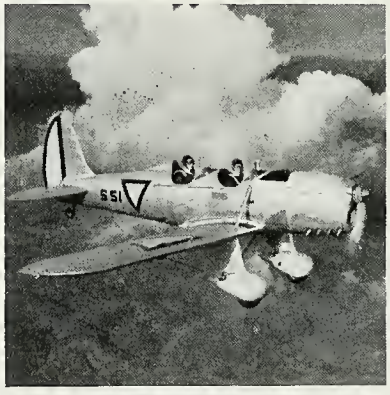
Eventually the station hopes to have a larger stand which will be able to mount the largest foreseeable missile complete and give it a preflight check under full thrust.

The novelty of operating such an extraordinary facility as the Experimental Rocket Engine Test Station is rivaled only by the fact that the Air Force at Edwards also operates two of the world's fastest—and shortest—railroads. Even though it holds the distinction of "blazing the trail," so to speak, with the inauguration of the world's first rocket-propelled passenger service, the Air Force's venture into the railroad business offers no immediate challenge to the nationwide network of railway systems.

The "railroads" are, of course, test tracks, and the Air Force uses them for a wide variety of research projects. The two tracks at the Air Force Fight Test Center are located at opposite ends of Rogers Dry Lake. A 2000-foot deceleration track used primarily for crash investigation and human factors research is situated north of the lake, and a 10,000 foot track used for highspeed tests under free air conditions is located on the south of the lake. A third track 3,600 feet long is located at Holloman Air Development Center, Alamogordo, N. M.

Air Force interest in track operations came about during World War II when Northrop Aircraft, Inc. began building rocket-propelled sleds for pulse jet missile research.

The first aerodynamic tests were performed on the 2,000-foot track with one of the missile launching sleds modified with a boom to hold a small model airfoil ahead of the sled. This vehicle streaked down the track at faster than sonic speed in 1946.



Still Flying

Evidence of the durability and long life of the Ryan STM monoplanes, built in the late 1930's and sold to the Netherlands East Indies, was afforded recently when civilian aviation officials in Oslo, Norway, inquired of the Ryan plant regarding this type plane.

Two Norwegian owners of a Ryan STM had applied for an airworthiness certificate, and the specifications were sought from Ryan by the Norwegian government. This particular plane had been used by the Royal Australian Air Force during the war, was sold as war surplus, and received a British Airworthiness Certificate in Hong Kong in 1948.

Ryan old-timers will recall that a fleet of STM's was shipped in the late 1930's to the Netherlands East Indies and later transferred to Australia after the Japanese overran the Dutch colonies. Many subsequently served private owners in various parts of the world, as the most recent query from Norway indicates.

Enough was learned from these first runs to convince engineers that a 10,000 foot track would be needed to obtain the desired high speeds and still stop the test vehicle before it ran out of track. Under Air Force specifications and sponsorship, Northrop designed and constructed what is now the 10,000-foot test track. Rails were laid and lined up during the night to avoid distortion from expansion and refraction caused by the heat of the sun and to assure accuracy within 1/16 of an inch in 100 feet of track.

Since its completion, the 10,000-foot track has been used to run seat ejection tests, parachute recovery systems, jettisonable crash location systems, aerodynamic flutter, some structures work and even acceleration tests on missile guidance.

At the present time a rocket propelled test sled capable of speeds twice that of sound is being used to study performance of parachute brakes operating in the transonic and supersonic ranges. This test sled was produced by the Cook Research Laboratories for the Air Force's high speed tests of aircraft and missile equipment. Designed and built by North American Aviation, the rocket engine powering the sled uses an oxygen-alcohol fuel to generate 50,000 pounds of thrust. It can accelerate the sled from a dead stop to over 1500 miles per hour in 4.5 seconds while traveling 5,500 feet.

Water braking has proved to be an extremely effective method of halting the supersonic vehicles from an entry speed of more than Mach 1. Mounted under the sleds is a scoop which is dipped into a water trough between the rails. The water is scooped up and turned 180 degrees, thereby stopping the sled within a few hundred feet by the transfer of momentum.

One of the most interesting tasks the 2,000-foot track has been used for is the long and continuing series of aeromedical experiments conducted by Lt. Col. John P. Stapp and other volunteers to determine human tolerances to abrupt decelerations.

To test a theory that Stapp thought would result in greater flying safety for Air Force personnel, and for passengers flying in commercial transports, Col. Stapp and his men subjected themselves to jolts calculated to be "bone jarring" at best, and often resulting in shock symptoms to the human guinea pig as well as occasional broken bones.

Purpose of the experiments was to learn how much force a person could withstand and still be conscious and able to make an exit from a crashed plane before cremated by the fire that so often follows a violent crash.

A "human decelerator" designed by Northrop was used by Col. Stapp in his experiments at Edwards. It was a 12½-

foot long, 600-pound sled of tubular steel, fitted with slippers designed to secure the sled to the rails of the 2,000-foot test track. It was propelled by three 125-pound rockets mounted in the rear which accelerated the sled from a standing start to 180 miles per hour in a distance of 500 feet.

Instrumentation and high speed cameras mounted on the sled itself and along the track provided the data Col. Stapp sought. This included information on the amount of tension applied to the seat harnesses, seat strength, displacement of the body at the moment of impact, velocity at brake entrance, rate of G buildup, and exit velocity.

Following a series of experiments designed to "shake down" the sled and its braking system and to test the types and tolerances of seats and harnesses, Col. Stapp in 1947 took the first human ride. Facing to the rear with the run set so he would receive only ten G at the moment of deceleration, the first run proved uneventful.

In the next few years Stapp and his men subjected themselves to higher G forces, improving their test equipment and safety harnesses as deficiencies became apparent. Runs were made of fifteen Gs, then twenty Gs, twenty-five Gs, and finally 30 Gs at which time the test subject suffered symptoms of shock. The 30 G run was rescheduled with the subject facing toward the rear and no difficulties were encountered, providing additional proof that rearward-facing seats, securely installed and equipped with lap belts of thirty or more G tolerances, are safest for passengers.

Col. Stapp continued the rides in the forward facing seats at a standard rate of onset of 1,000 G per second until finally, on a 38G crash impact force, he suffered a multiple fracture of the right wrist when his hand flew from the hand grip of the seat even though it had been strapped there. This and other related runs showed that man could not safely sustain crash forces of more than 35 G with an onset rate of 1,000 G without suffering shock or injuries that would prevent him from getting out of a burning aircraft.

Convinced that crash injuries were not caused by how hard a force hit, but how fast, Col. Stapp felt that he could tolerate more than 38 Gs, provided that the force was applied over a greater elapsed time. The force on the 38 G run was applied in .16 seconds.

To prove his point, Stapp made one last run in 1951. Roaring down the track at two miles per minute, the sled hit the brake and stopped within 19 feet. In an elapsed time of .23 seconds Col. Stapp had withstood a crash impact of more than 45 Gs.

Although somewhat the worse for wear, what with the veins of his right eye hemorrhaging and his heart pulsing at 130 beats a minute, Stapp has proved his theory.

Now Chief of the Aviation Biology Field Laboratory at Holloman Air Development Center, Col. Stapp is currently engaged in track research aimed at developing equipment to protect air crews bailing out of aircraft traveling at supersonic speeds.

In the near future, Air Force volunteers will be strapped in the seat of a rocket sled traveling more than 750 miles per hour. As the sled streaks along Holloman's 3,500-foot track, the human "guinea pig" will be rotated head over heels 180 times per minute, exposed to the same wind-blast forces a pilot ejected suddenly from a supersonic aircraft would experience. In Holloman's relatively dense air, the results would be comparable to a bailout from an open seat at 40,000 feet at a speed of 1,800 miles per hour.

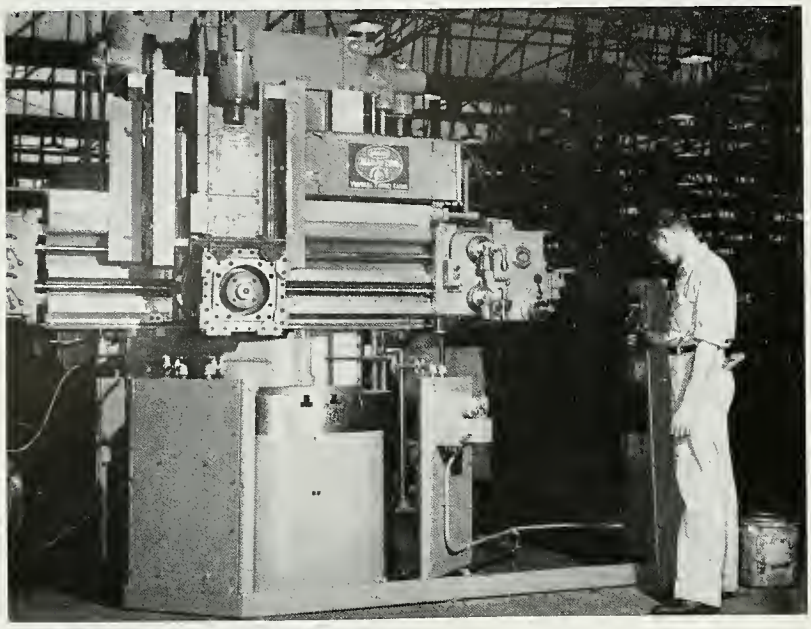
Distinguished Officers See Firebees

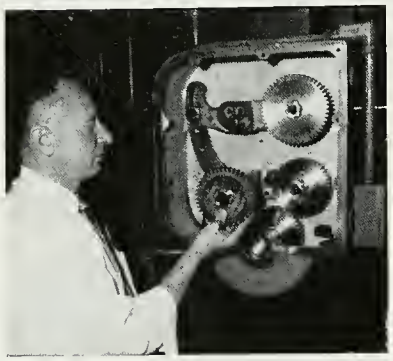
International as well as national interest in Ryan's Firebee pilotless jet target drone was indicated recently when two distinguished groups of Canadian and American military air officers visited the Ryan test facilities at Holloman Air Development Center, Alamogordo, N. M.

Pictured above as he examines the unique design features of the Firebee with Ryan engineering officials is Lt. Gen. Donald L. Putt, commander of the U. S. Air Force's Air Research and Development Command, the headquarters of which is located in Baltimore, Md. With him are, left to right, Col. Paul H. Kemmer, USAF (Ret.), chief designer in Ryan's engineering division, and Bruce Smith, director of engineering. Holloman is one of nine research, development and testing centers under the jurisdiction of General Putt's Air Research and Development Command.

Shown below as they inspect a Firebee shortly before it is carried aloft by its launching aircraft for another air launch mission are, left to right, Squadron Leader F. G. Fellows of the Canadian Joint Staff located in Washington, D. C.; Capt. John W. Richards, Lt. Col. T. V. Ahola and Lt. Col. C. F. Cole of Holloman Air Development Center; and Group Capt. C. B. Limbrick, director of Armament engineering at RCAF headquarters in Canada.

Automatic Lathe First Of Its Kind In Plant





First vertical turret lathe of its kind in the plant is this "Man-Au-Trol" 42-inch Bullard, just installed in Department 130, machine shop. It can be operated automatically after making one setting. G. N. Cottrill, operator, checks control column in photo above. Ray Yerkey, methods engineer, at left, demonstrates one of the unique features, use of gears to obtain any desired angle or taper. The lathe, installed in space formerly occupied by part of the inspection crib in the main factory building, will be used primarily for KC-97 Boeing parts.

DRONE DESIGN

(Continued from Page 1)

The nacelle is also of semi-monocoque construction with formed magnesium skin on dural longerons and frames. Stainless steel is used in all areas of engine heat. The nacelle is attached to the fuselage at four points with the two forward fittings acting as hinges to permit ready access to the engine without removing the nacelle from the fuselage. Complete with engine installed, the nacelle weighs only 500 pounds.

The full cantilever wing is unusual in that no ribs are provided in the wing panels other than at the root and tips of the outer panels. The right, left and center panels comprise a single manufactured unit. The outer wing tips are removable and easily replaceable in the event of damage at impact following parachute recovery of the drone. They are constructed of light magnesium skin on magnesium spars and are attached to the outer panels of the wing by means of piano hinges on the upper and lower surfaces. The main and center panels are of heavy guage aluminum alloy skin with three 24ST spars.

The empennage is of semi-monocoque construction with formed magnesium skin, dural magnesium frames and a stainless steel deflector plate. Provision is made for the attachment of the tail group as well as the two-section tail-cone housing the parachutes. The ailerons, elevators and rudder are of semi-monocoque construction with magnesium skin on light dural spars and are statically balanced.

The full cantilever horizontal and vertical stabilizers are of the same type construction as the wing with all three panels comprising a single assembly. No ribs are provided in the structure other than at the tips. The vertical fin has a removable tip above the rudder which is attached to the fin by two piano hinges. Construction is of magnesium skin on dural spars.

As the first step in assembling the target, the fuselage is supported in a target handling dolly; then the wing section is removed from its packing crate and attached as a single unit to the fuselage by four readily accessible self-aligning bolts. The jet engine is easily installed in its nacelle and the complete power package is then placed on a dolly and rolled into position for attachment to the fuselage with four bolts.

The empennage, fabricated as a single unit, is put into position without the need of handling equipment and quickly fitted and bolted into place, aided by conical fittings to insure alignment. Then the tail cone containing the recovery parachute is attached and, with the exception of several small fairings, the target is completely assembled.

It became apparent early in the Firebee project that in order to obtain repeated use of the targets a practical recovery system would have to be designed. Hence, Ryan and Air Force technicians developed a two-stage parachute recovery system to decelerate the drone from speeds up to 600 miles per hour and lower it safely to the ground without harm to the delicate equipment inside. The five foot "drag" chute and the 70-foot main suspension chute flare out from the tail cones at the command of the remote control operator. In the event of a target hit, engine failure, or loss of radio wave carrier from the remote control station, the recovery system operates automatically.

In many respects, the problems involved in the development of the Firebee were greater than those in designing a conventional man-carrying jet plane. In addition to the normal aerodynamic factors, Ryan engineers had to cope with the eccentricities of a remote control system, an autopilot system and, of course, the parachute recovery system.

The target is controlled by command signals which are transmitted from the ground to the drone by means of a "black box" containing stick and switches to govern the engine speed and other flight conditions. The command control system installed in the target received "instructions" and channels the signals to the proper control surfaces. From the ground remote control station, the target drone can be flown out-of-sight and at high altitudes while being tracked by electronic devices.

Currently the Firebee is involved in two separate test programs at Holloman Air Development Center. With the research and development program conducted by the Ryan test group nearing completion, the Firebee has entered a new phase known as "operational suitability testing" (OST), which is now being conducted by an Air Force Operational Test Center group from the Air Proving Ground Command.

KING OF THE HELICOPTERS

(Continued from Page 6)

A cargo "pack" fastened to the belly of the aircraft can be loaded and unloaded or moved about on the ground, independently of the helicopter, to augment its interior capacity. Gross weight of the YH-16 is more than 15 tons. Its cruising speed is greater than any helicopter flying today, including its predecessor, the H-21, which holds the official world record of 146.7 miles per hour.

The gargantuan dimensions of the Transporter are not considered awesome by Frank N. Piasecki, the founder and board chairman of Piasecki Helicopter Corp.

"Even today," he says, "we can foresee the design of helicopters over 200,000 pounds in weight. The size and capacity of helicopters show no inherent technical limit. Larger and larger machines, capable of lifting heavier and heavier loads, can and will be built as the basic workings of commercial economics and military planning dictate."

Piasecki foresees amazing advances in the speed capabilities of helicopters. This will come about through a blending of two developments, he believes. Helicopter designers will add speed to their machines, and airplane designers will add vertical-lift capabilities to their high-speed craft. The result: A joining of designs in machines fully capable of both helicopter flight as we know it today and high-speed flight at velocities far beyond even today's experimental supersonic speeds.

Originally designed as a long-range rescue helicopter, the YH-16's enormous load-carrying capacity has caused the Air Force and the Army to consider its use in military logistics. And Piasecki is looking ahead to wide-scale commercial adaptation of the YH-16. Its availability for this purpose may be five or more years off, but in the meantime, the H-21, now being produced in three models, as a rescue craft, an assault transport and a cargo and personnel transport, is considered by Piasecki officials as the first production model big enough for commercial use.

The helicopter is peculiarly adaptable to airlines for short haul inter-city service. A comparatively high speed helicopter such as the YH-16 might be considered ideal to carry 40 to 60 passengers between cities up to 300 miles apart.

Capt. Eddie Rickenbacker, chairman of Eastern Airlines, has said that the "development of the helicopter has come along so fast that every city in the country interested in its future commercial development should plan early creation of suitable heliports, not only to transport people between the center of populated areas and the outlying airports, but also for regular inter-city 'commutation' travel." He believes that this stage of air transport may well be reached by 1960.

A major attraction of the helicopter to commercial operators is the low capital investment of related facilities needed to support its operation. The railroad needs its tracks and right of way, the truck must have highways, the steamship must have harbors and docks, the airplane must have airports, but the helicopter can land and take off in a small area, and needs less supporting accommodations than any other vehicle.

Piasecki's ranking place in the helicopter world is based on its pioneering of the twin-tandem principle for its power plant. The first Piasecki helicopter, produced in 1943 by a firm then known as the P-V Engineering Forum (the V for Harold Venzie, an early partner who is no longer with the company) was a single-rotor craft, designated the PV-2. It was the only single-rotor helicopter ever built by Piasecki. Soon afterward, the Navy awarded the company a contract to design and produce the first tandem-rotor transport helicopter, the XHRP—the first "Flying Banana"—which flew successfully in 1945. Only a small number of the HRP series were built. Then followed the HUP series for the Navy (Army designation: H-25), with a straight fuselage, and the H-21 (back to the "banana" shape). These have been the two major production models to date.

Developed for the Navy to provide a compact shipboard helicopter for rescue and utility missions, the HUP-2 was the first production aircraft of its kind to use an automatic pilot. With blades folded, it can be lowered in a shipboard elevator. The H-25, known as the Army Mule, can carry three men on litters for battlefront evacuation.

The tandem design—with a rotor forward and another on the tail—goes a long way toward overcoming the bugaboo of helicopters, lack of stability. High overloads and shifting of passengers in flight without disturbing balance requirements are permitted. And the counter-rotating rotors counteract torque without expenditure of extra power.

As a "partner" in the production of Piasecki helicopters during the company's meteoric rise to the top of its field, Ryan shares the "horizons unlimited" view of Frank N. Piasecki. Ryan's long experience in the field of exhaust systems has helped Piasecki lick some of the difficult power plant problems that arise in unprecedented designs. As helicopters demand increasing power to extend the scope of their usefulness, Ryan's engineering and production facilities will keep pace with Piasecki progress.

Westinghouse Official Views Ryan Production

Ryan's production capabilities in the field of jet engine components were viewed recently by W. W. Smith, right, manager of the Westinghouse Aviation Gas Turbine Division, Kansas City, who also took special interest in the work being done here for that company, including the afterburner for the J-46 engine. Smith was accompanied to Ryan by his industrial engineering consultant, P. B. Taylor, shown at left. Robert L. Clark, assistant factory manager of Ryan, is in center of above photo.

SEES WITH INWARD EYES

(Continued from Page 11)

job on his own. His experience and qualifications attracted Ray Morton, Ryan employment supervisor, and after conferences with Earl D. Prudden, vice president, and W. S. Cockrell, engineering laboratory chief, the decision was reached to hire him as a research analyst in the laboratory.

Now Saiger not only performs the tasks assigned to him, but he has assumed other duties of his own volition.

"For instance, he has taken the responsibility of keeping our lathe and drill press in good repair and properly lubricated," Alderson says. "One of the most remarkable things we've seen in the laboratory was Bill's taking the lathe apart from stem to stern, cleaning every part, even to polishing down the small burrs that had developed, and reassembling it. That lathe has never performed better.

"He's the aggressive type who looks for work and is unhappy when he has to wait to be told to do a job."

One of Saiger's principal assignments has been testing the thousands of electrical relays that come into the Ryan plant for use in various projects. He devised a rig for checking these relays with a battery-operated "clicker," and has been able to test as many as 200 relays a day.

Solenoids also require testing, which he performs by connecting them to a test panel, hanging a ten-pound load on his arm, and throwing the switch to determine whether the load can be lifted. In a 90-minute stretch recently, he tested 69 such solenoids.

He leaped at the opportunity to do a production type job when he was assigned to the metallurgical section of the engineering laboratory on a special assignment dealing with experimental wing panels to be placed under stress. Saiger did countersinking and burring, completing a panel a day over a month and a half period. Using a pneumatic drill with countersink and micrometer stop, he was able to perform this work as rapidly and efficiently as a sighted person.

He has disassembled fuel level indicators on which the faces were to be replaced, and he has reassembled the instruments after checking for short circuits by using a small relay and a 1½-volt battery. He has built meters to measure the thrust of Ryan "Firebee" pilotless jet target planes, an operation that required the use of a soldering iron in connecting plugs to cables.

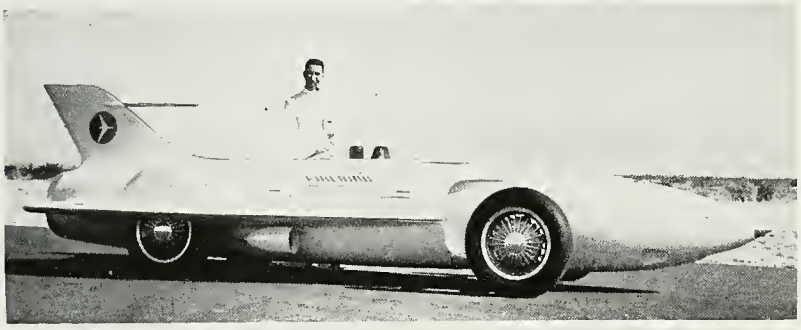
When Saiger applied for work at Ryan, he was guided into the employment office by a German shepherd guide dog. Today he needs no such help on his job. A fellow employee drives him to work and sees him to the laboratory door. Once inside, he knows every inch of the place and "scoots around as well as anyone else," Alderson comments.

At home, Saiger keeps busy, too. He has a workshop in his garage, where he repairs radios for neighbors and others, and where he has just built an amplifier and a maple cabinet for a high fidelity record player.

In the past year, he has "read" 75 full-length novels and textbooks through the medium of recorded literature sent him by the Library of Congress. Occasionally, he hires a reader when he can't get the record he wants. Although his wife is sighted, Saiger believes it best not to place too much of a burden on her by asking her to read for him.

He is studying ethnology and anthropology and has gone deeply into the evolution of mysticism, and the causes and control of climate.

Obviously, William John Saiger is not an ordinary blind man. That may be why hiring him has proved such a success.



LANDBOUND FIREBIRD—General Motors' XP-21 Firebird, first gas turbine auto built and tested in the United States, resembles Ryan Firebird missile developed here several years ago. Test driver is Mauri Rose, former Indianapolis Speedway champion.

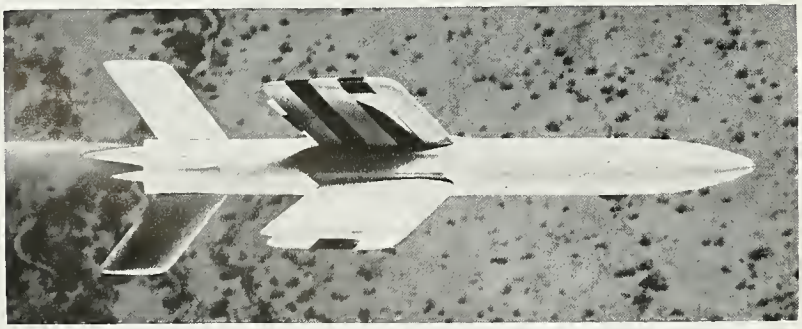
New G. M. Gas Turbine Auto 'Borrows' Firebird Designation

General Motors' new experimental gas turbine-powered automobile is based on an aircraft theme, even to the name XP-21 Firebird, "borrowed" from Ryan's own Firebird missile, unveiled several years ago as the first publicly announced air-to-air missile.

Not only does the car have the same name as the Ryan missile, but features of its appearance are similar to those of the missile, from the thin, knife-like tail to the pointed nose. To top it off, the P-21 designation is even the same as that of a noted Ryan plane, the PT-21 World War II primary trainer. And to carry the "21" parallel still further, Ryan now is in quantity production of XM21 Firebees, pilotless jet-propelled target planes for Army Ordnance.

Power plant of the XP-21 Firebird is a 379 h.p. Whirlfire gas turbine engine, installed to determine whether this type of power is feasible for automotive use.

"The gas turbine engine offers some advantages over the conventional piston engine," Charles L. McCuen, G.M. vice president and general manager of research laboratories, explained. "But these must be balanced against a number of disadvantages. We want to study both. We want to know what the turbine can and cannot do."



AIRBORNE FIREBIRD—This was how the Ryan Firebird appeared in flight. Note general configuration similarity to General Motors' experimental auto. Ryan product was first air-to-air missile publicly disclosed by the Air Force.

BOEING KC-97s HIT 500 MARK

(Continued from Page 5)

quantity production program. More than 300 such improvements have been introduced, and the gross weight was boosted from the original 120,000 pounds of the experimental prototype to 175,000 pounds for the latest KC-97G. Although production is now tapering off, the program remains dynamic. Boeing believes that the Stratofreighter has even greater potentialities as a turboprop transport, and two of the planes are being modified for installation of new Pratt & Whitney T34 turboprop engines. The first of these planes is scheduled to fly late this year.

The KC97s have become the standard Air Force aerial refueling tankers in world-wide use by the Strategic Air Command and the Military Air Transport Service. Such refueling of jet fighters, bombers and reconnaissance aircraft has become routine operating procedure. For instance, twenty KC-97s are now attached to each 45-plane wing of Boeing B-47 Stratojet bombers. The SAC now makes a mid-air refueling contact on the average of once every 15 minutes, 24 hours each day, seven days a week. Their use is not limited, however, to this purpose. They also are equipped to serve as cargo and personnel transports for various Strategic Air Command units.

The Military Air Transport Service, primarily in the Pacific area, uses a fleet of transport Stratofreighters on regularly scheduled cargo and passenger flights from the United States to Japan. These were the principal aircraft used for evacuation of wounded men from the Korean theater. With completely pressurized crew and passenger-cargo compartments, the Stratofreighters can cruise at 25,000 feet, with cabin pressure of only 5500 feet. Non-stop cargo and passenger flights are made between Tokyo and Honolulu, as the C-97s take advantage of high-altitude, high-speed jet stream winds.

Since the first XC-97 was built, Boeing also has delivered 56 commercial versions, the Stratocruiser, to Pan American World Airways, Northwest Airlines, United Air Lines and British Overseas Airways Corp. These are among the most luxurious of airliners. The double-deck air cruisers have carried some 2,500,000 passengers in the past five years and have flown more than 125,000,000 plane miles.

Ryan has proudly participated in the production of the world's most magnificent air fleet of tanker-transports.

Air University Leader Here

An officer who rose from lieutenant's rank in 1939, when he was second in command of the Air Force personnel at the Ryan School of Aeronautics, to brigadier general today, was a visitor to the Ryan plant last month.

He is Brig. Gen. Lloyd P. Hopwood, now commandant of the Air Command and Staff School of the Air University, Maxwell Field, Alabama, where the latest developments in aviation concepts are imparted to selected groups of officer students.

Accompanied by the Air University's top instructors on a nationwide tour of familiarization with new projects, Hopwood viewed the Ryan Firebee, pilotless jet-propelled, high speed target plane under production in quantities here. Hopwood's advance to general's rank has been watched with interest at Ryan, since he served here 15 years ago at the Ryan school, one of the first nine private schools in the country "drafted" by the Air Force to provide instruction to the swarms of cadets entering the service.

In 1941, Hopwood was transferred to command Ryan's new school at Hemet, which became noted as one of the most successful operations of its kind in the country.

T. Claude Ryan, company president, at left, gives Brig. Gen. Lloyd P. Hopwood and instructors of the Air University details of Ryan's spectacular Firebee pilotless target plane. Hopwood, in civilion clothing, is directly in front of Firebee's nose.

ELECTRONS AT WORK

(Continued from Page 15)

ders is, of course, the electron tube. By means of these tubes the smallest particles of matter—electrons—are isolated so that they can be harnessed and put to work. Edison, although he didn't realize it at the time, developed an electron tube as early as 1883. The electron tube as we know it, however, was developed in 1906 by De Forest.

Most conventional electronic assemblies consist of tubes for detection and amplification, a maze of wiring, resistors, capacitors and various other components. Cramming this complex bulk into aircraft is an eternal battle for space. The aeronautical electronic design engineer, like other aeronautical design engineers, is faced with the acute problem of size and weight as well as stability, ruggedness and reliability. As a result, compactness has given way to miniaturization and miniaturization in turn has given way to subminiaturization in present-day airborne electronic equipment.

Great strides toward shrinking the size of electronic equipment have been made in recent years as a result of a complete revision of all customary materials and methods of construction used in the past. This has led to the development of the much-publicized transistor, a tiny particle of germanium metal that controls electrons in solids in much the same manner that tubes control electrons in a vacuum. Eventually transistors will replace electron tubes for many tasks. Other oustanding developments, such as printed circuit techniques and the Navy's "Project Tinkertoy" modular design system, are aimed at simplified electronic design and faster production.

Ryan's electronic laboratory is using the printed circuit technique in subminiature plug-in assemblies for Ryan airborne navigational equipment and other classified

(Continued on Page 28)

equipment in military contracts. This method replaces the conventional wiring method, which consisted of soldering a wire to one component, running it to another, then attaching it electrically by soldering again. The components also had to be mechanically fastened to the junction points.

The new method starts with a copper-coated, moisture-resistant plastic sheet, 1/16th of an inch thick. The pattern of the wires connecting the components is drawn on top of the copper side with an acid resistant ink. Photographic techniques will be used in the event that large quantities of such patterns are needed.

The sheet is then dipped in an acid solution which etches away the unwanted copper between the conductors. The ink is washed away, leaving only the plastic sheet with the copper strips, or "etched" wires. Small holes are punched and eyelets inserted at terminal or junction points where the components leads are to be connected. Into these eyelets are dropped the connecting wires of components such as the tubes, resistors, capacitors, etc., which are mounted on the opposite side of the plastic sheet.

The entire assembly is lowered into a pot of molten solder with the conductor side down. Solder flows into the eyelets around the junctions, assuring firm electrical and mechanical contact, and in three or four seconds, the 75 or more solder connections on a typical board are completed. The result is a subminiature electronic sub-assembly, light in weight, small in size and low in cost.

Ryan's prominence in the field of electronics research has come about as a result of its work in producing the first air-to-air missile—the "Firebird"—several years ago. While much of Ryan's work is necessarily obscured by the shroud of military secrecy, it is well-known that Ryan occupies a leading position in the development and production of tiny electronic devices which can "think" in the body of a whizzing missile. A typical Ryan-built radar system is so small it can be carried in a handbag.

Ryan has also made a significant contribution to the field of airborne navigation with the development of a revolutionary navigational device that has been sorely needed for many years. Extremely versatile, this equipment provides a means of accomplishing navigation and other special tasks such as bombing and photography. Other interests are centered upon the development of special airborne devices for helicopters.

Electronics in aviation is not just a matter of vacuum tubes and their associated bits and pieces of electrical complexity. A large amount of the electronics work is mechanical and involves considerable sheet metal work in chassis fabrication, plastics work in the design and fabrication of radomes, controls for tracking antennas and mechanics associated with servo-mechanisms for antenna positioning. Not to be overlooked are the antennas, microwave plumbing, hydraulic devices and the extremely small and efficient liquid-cooled motors that the Ryan electronic section has designed and is fabricating for electronic systems.

Now in the developmental prototype phase, these items will probably be required in large quantities in the future. This will result in large scale production, requiring the full use of Ryan's versatile manufacturing facilities.

For the research, development and test evaluation of this complex equipment, Ryan is in a particularly advantageous position because of its extensive experience in and facilities for the production, operation and maintenance of aircraft. Ryan expedites its flight evaluation of experimental equipment by operating a fleet of aircraft from the runways of Lindbergh Field, which adjoins the Ryan plant.

For this purpose, a Navy Lockheed twin-engined P2V Neptune and an Air Force North American F-86 Sabrejet fighter, the famous "MiG killer" of the Korean conflict, have been loaned to Ryan for in-flight testing. A Ryan Navion comprises the third plane of this team.

Should malfunctions of the experimental devices aboard the aircraft occur, "trouble shooters" from the electronics laboratory are immediately available a short distance from the Ryan flight line to make "on-the-spot" corrections or repairs. Ryan also has a ground testing station on wheels in the form of a specially modified truck containing a host of electronic testing devices. Used primarily for field testing, the truck has just recently returned from the Air Force Flight Test Center, Edwards, Calif., where it had been utilized in a series of ground tests conducted on Ryan-designed electronic equipment.

During the design and development phases of any electronics system, certain analytical problems arise that must be solved before work on the system or component can continue. The job of answering these questions is that of the systems analysis group. Since some of these problems, such as the analysis of error or the limitations of an electronic system, are of such magnitude, electronic computers are utilized to a large extent in providing the answer in a minimum of time.

In the past, Ryan engineers shared the facilities of the company's tabulating equipment in the accounting department in working the problems. Recently, however, the volume of such problems has grown to the extent that it was found necessary to form a technical computer group under the engineering department. This group will be equipped with a new Card Programmed Calculator and an Analog Computer, as well as auxiliary tabulating machines and equipment. Problems that formerly required nearly a thousand man-hours to complete by means of desk calculators can be performed in less than eighty man-hours on present electronic computers. With the arrival of the new equipment, this figure will be slashed in half.

Ryan's electronics section, headed by Owen S. Olds, continues to expand to meet the ever-growing demands of military and commercial aviation for new and improved electronics equipment. With work underway in new and promising fields of electronics research, Ryan is well qualified to play a major role in the development of new capabilities and applications in the vitally important field of airborne electronics.

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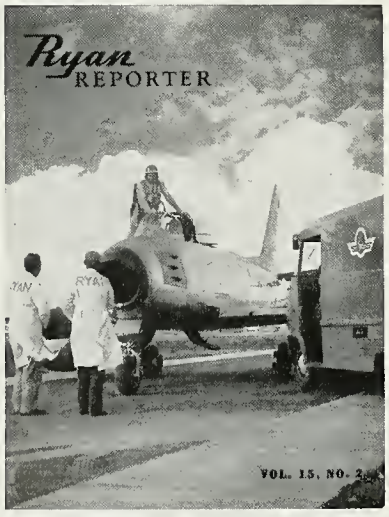

Ryan engineer, Al Coha, checks F-86 prior to flight evaluation of new device developed in Ryan electronics laboratory while mobile truck monitors. (This is replica of cover picture.)

Where do profits go?

To increase your standard of living

OUT of every dollar you spend, less than 5c can be kept as profit by the average company supplying you. *(At Ryan the profit is less than 3c.)* A good part of that 5c is then used to buy new machines. (Only 2c ever reaches the owners as dividends.)

These new machines produce more, at lower cost. To stay in business in America's highly competitive system, machine owners pass on those lower costs to you in lower prices. (Remember your first mechanical refrigerator at $700, your first radio at $400?)

Stop the profits and you will stop this process of better and better values. As machines grow older they will produce less and less and so what they produce will cost you more and more.

Remember that, next time you hear someone attack profits. He's recommending higher prices for you.

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P. O. BOX 311
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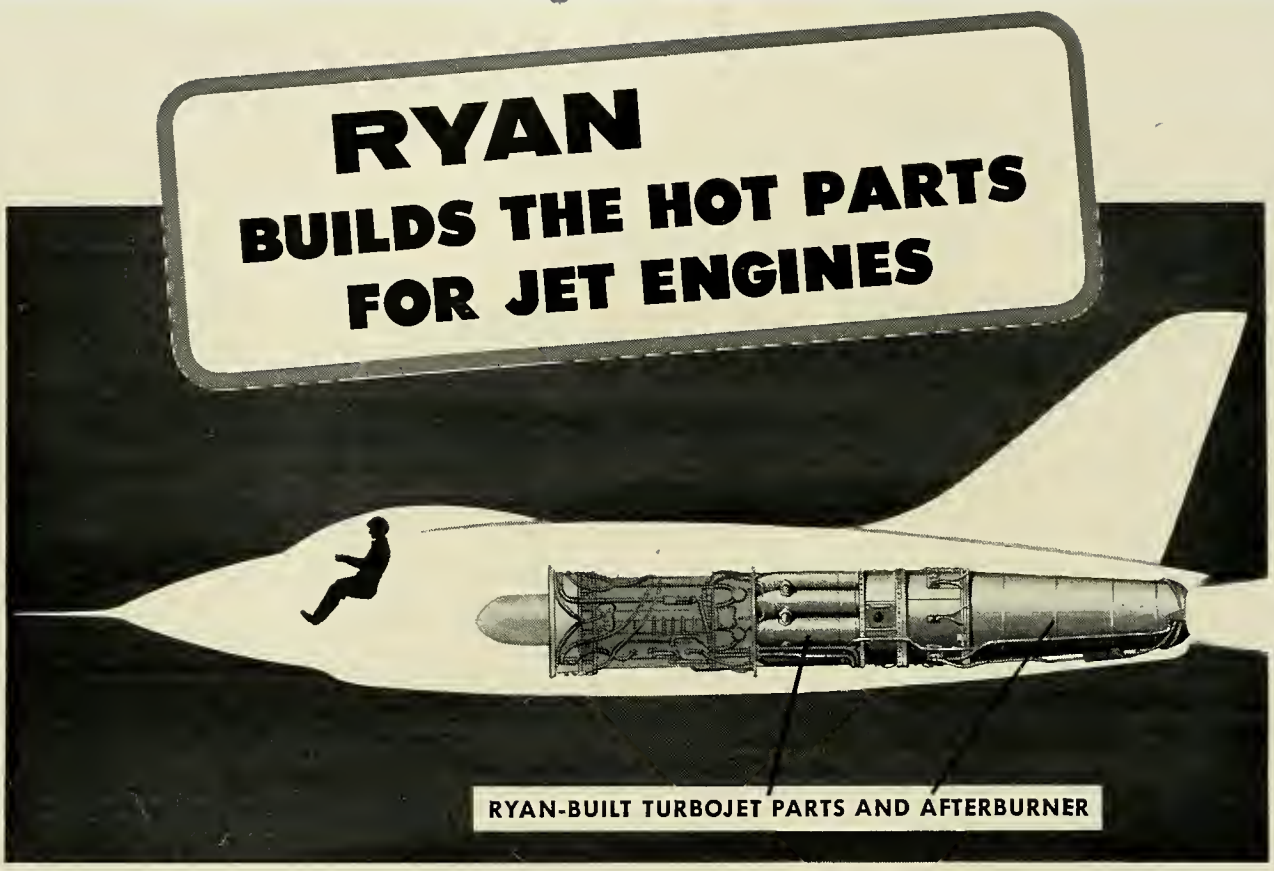
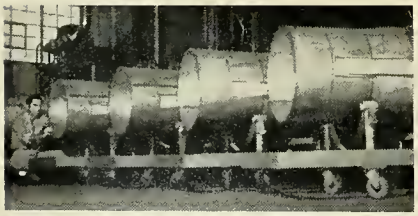
RYAN BUILDS THE HOT PARTS FOR JET ENGINES



RYAN-BUILT TURBOJET PARTS AND AFTERBURNER

The startling performance of America's great new fighters and bombers depends largely upon the knowledge and skill of the manufacturer of their jet engine components. These rugged "hot parts" must be built to jewel-like precision and exhibit amazing strength under extremely high temperatures.



Ryan Afterburners for Westinghouse J-46

Ryan is a pioneer in this field, developing the first American jet engine afterburner in connection with the Navy's first jet plane, also built by Ryan. Today, Ryan leads in the fabrication of sheet metal turbojet components and afterburners because of a unique combination of advantages: long experience in high temperature metallurgy – extensive know-how in forming, welding and machining heat-resistant alloys – the industry's most modern array of high precision machines. Few plants anywhere have the necessary equipment, methods and know-how for this specialized work.

With these facilities, Ryan is building afterburners and jet engine parts for General Electric, Westinghouse, Pratt and Whitney Aircraft, Wright Aeronautical and others. Ryan's $4 million worth of modern production tools produce high temperature jet engine components used in North American F-86 and F-100 Sabres, Boeing B-47 and B-52 Jet bombers, Convair F-102 fighters, Douglas F4D Skyray fighters and A3D attack bombers and McDonnell F-101 fighters. Currently, Ryan is building six different types of afterburners.

As the only maker of jet engine parts which also designs, builds and flies jet aircraft, Ryan is uniquely qualified for this exacting work. In virtually *every* field of aircraft development and production, Ryan is better prepared to solve the complex engineering and fabrication problems posed by the high speed·air age.

RYAN

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RYAN AERONAUTICAL COMPANY

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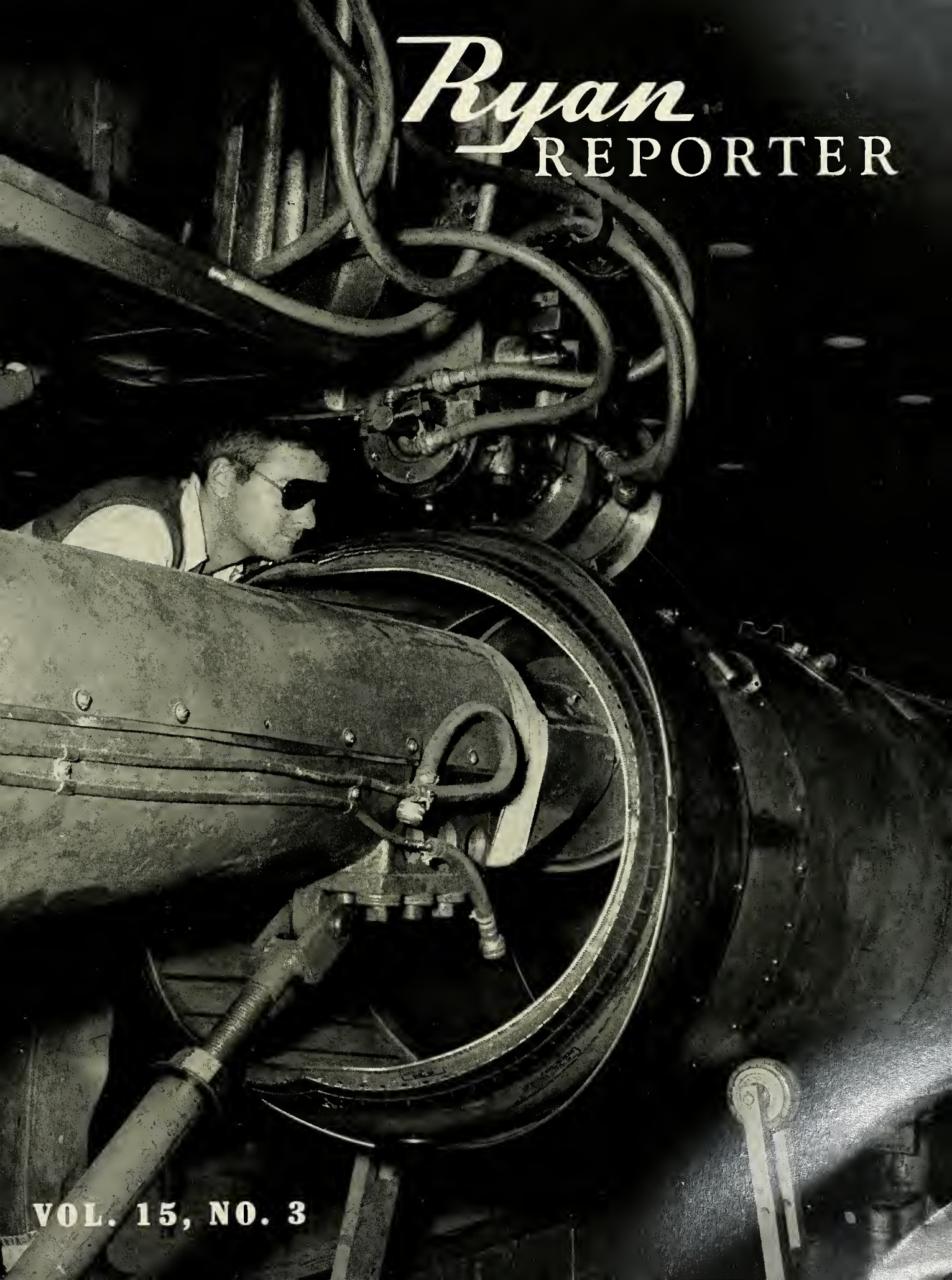
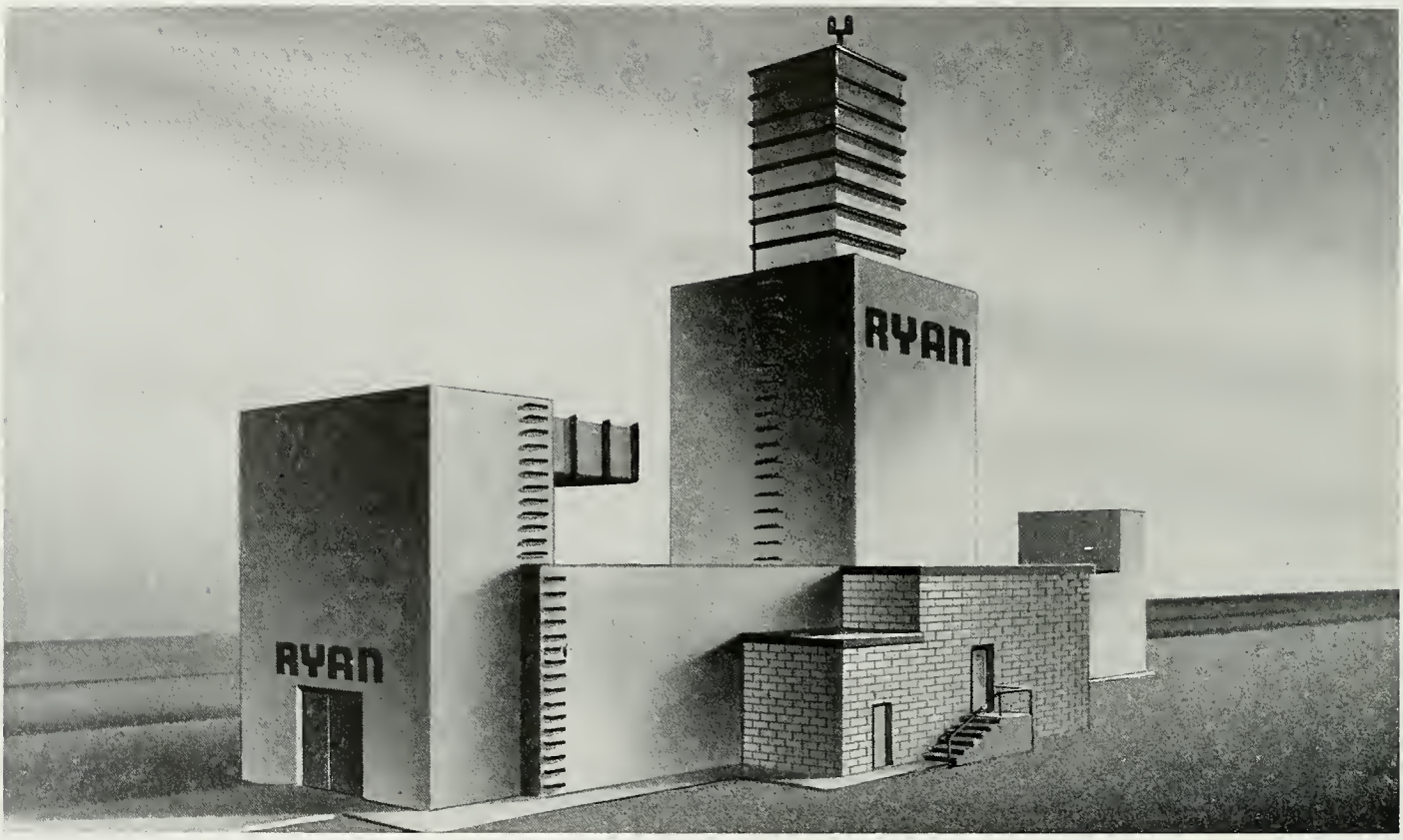
Other Offices: Washington, D.C.; Dayton, Ohio; Seattle, Washington; New York City



Ryan REPORTER

VOL. 15, NO. 3

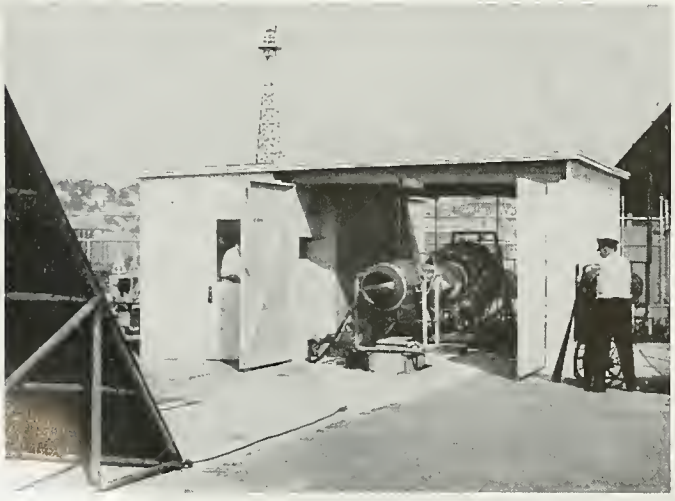


With two foot thick walls, Ryan's newest research tool is monolithic chamber. Towering air intake stacks will feed jet stream.

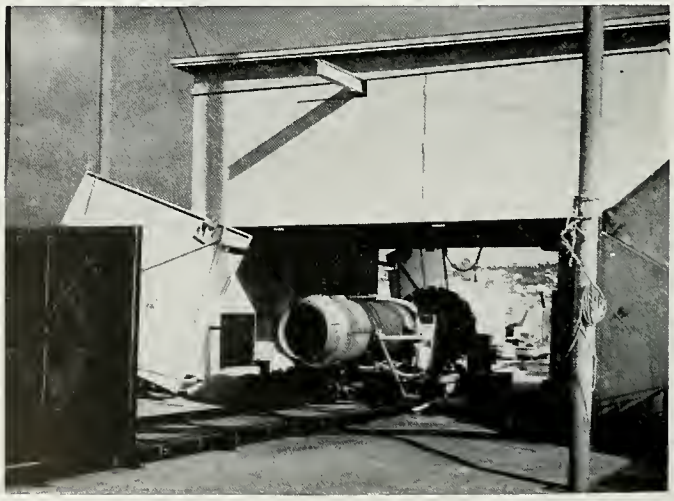
JET TEST TUBE

Ryan's new jet engine test cell has been designed to let the secrets out but keep the thunder in

Built in 1946, Ryan's first jet engine test cell was used to develop America's first commercially built afterburner.



In 1949, the present facility was placed in service. It will augment the new structure in handling jet engine research.



RYAN Aeronautical Company is building a new jet engine test cell which will be the largest in the San Diego area and comparable in design to the best facilities in the country. Costing $175,000, it will be the third jet engine test cell which the company has constructed since 1945.

The need for the new test facility underlines the importance of jet engine research at Ryan where there is a unique, dual requirement for advanced knowledge in this field. One branch of Ryan interest is in the development and manufacture of high-temperature components for jet engines, including complete afterburners. The other is in connection with improved designs and applications of jet propulsion to Ryan airplane designs, both piloted and pilotless.

The new jet test facility will be modern and complete. It will contain two test stands capable of handling the most powerful jet engines and afterburners of today as well as future power plants, ranging up to thrust ratings of 35,000 pounds. The latest water-spray equipment and acoustic silencers will be used to efficiently muffle the roar of engines under test.

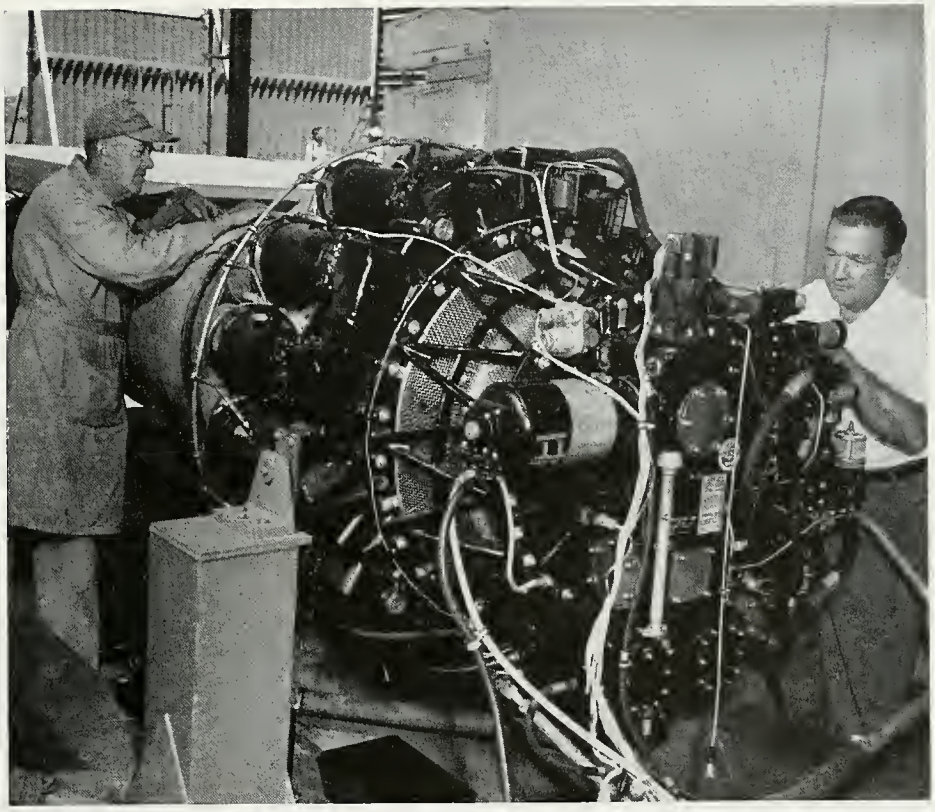
The new structure will be a massive concrete building with walls two feet thick. The main building will be 70 feet long, 40 feet wide and 40 feet high. Immediately adjoining this building will be another structure housing the control room and utility area. They were designed by the Ryan plant engineering department.

Located at the northwest corner of the Ryan plant site, the buildings will rest upon a grid of reinforced concrete beams. The beams will be supported by 45 piles sunk to depths of 50 feet. An underground fuel storage tank of 10,000 gallons capacity will be installed with space provided for a second tank of the same capacity. From this reservoir, a pumping system will deliver up to 200 gallons of filtered fuel per minute to feed present engine requirements.

Two huge air intake stacks will be contained within the towering walls of the structure. The first will have a cross section of 10 by 23 feet and will duct volumes of air to the power plant undergoing test. The other stack, measuring 20 by 23 feet in cross section, will supply cooling air which will mix with the intensely hot blast of exhaust gases ejected from the test stand. By diluting these seething gases, the air will produce a silencing effect as well as protect the equipment from high temperature deterioration.

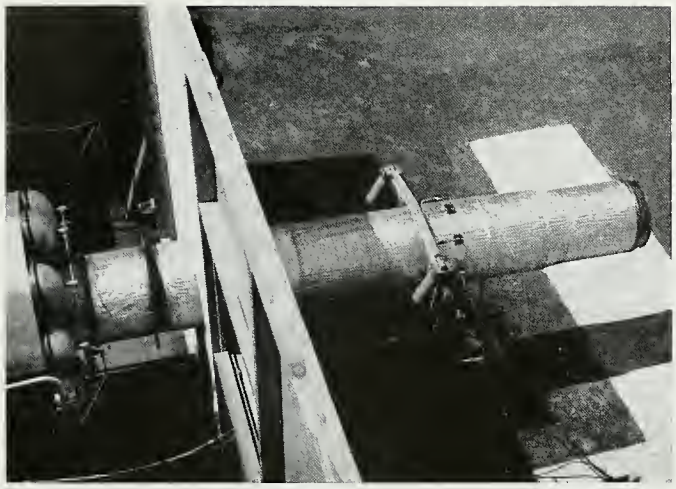
The intensely hot gases rushing from the test stands will be channeled through

(Continued on Page 24)



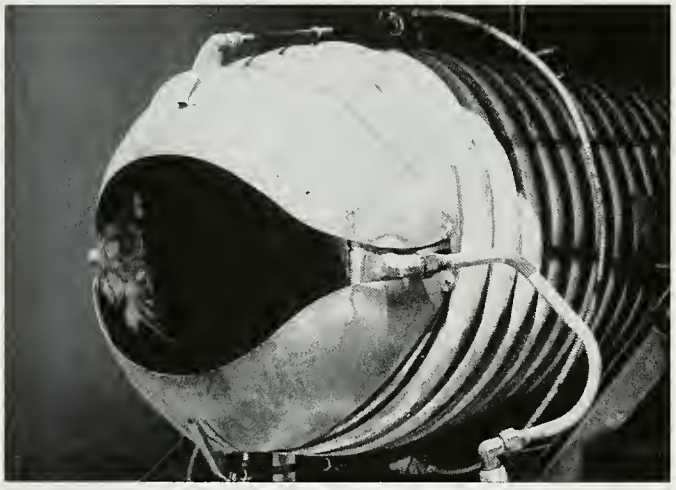
Charles Jensen and Edward Sly prepare turbojet for test run. Test cell is shake down facility for engines as well as "torture chamber" for new designs and alloys.

Cold water shower will cool and muffle roaring, seething jet gases as they rush from test chamber. Installation will be similar to that used by the General Electric Co.

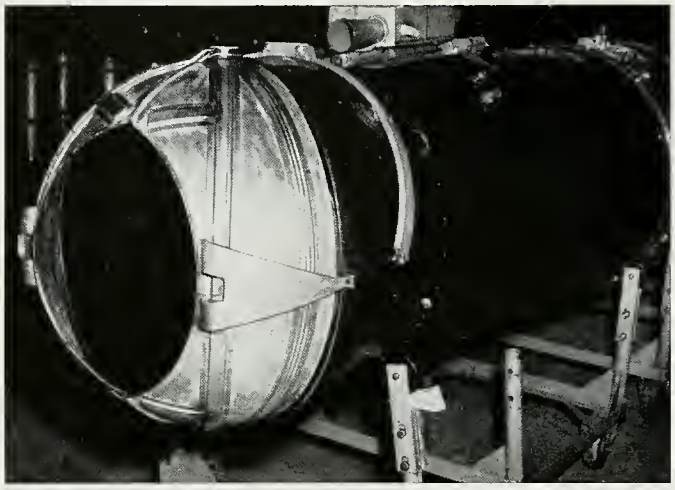


Insulated tail-pipes, built by Ryan in 1944 far installatian in Ryan jet planes, provided early experience in jet parts.

Modern tail-pipes for General Electric J-47 turbajets are precision-made to short length to fit padded pawer plants.



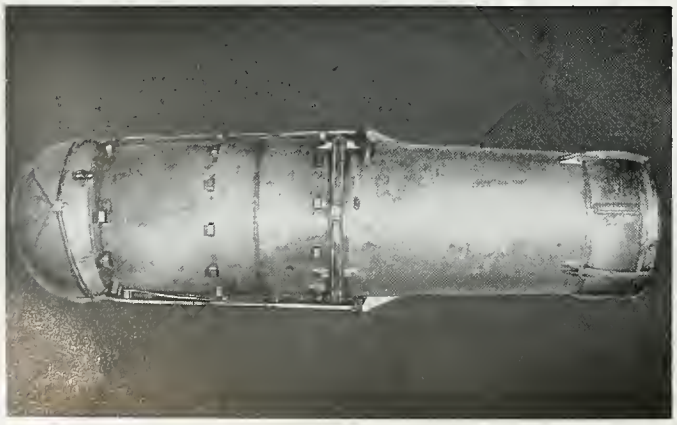
Early "eye-lid" nozzle system designed by Ryan ta maintain desired temperatures and back pressure during afterburning.



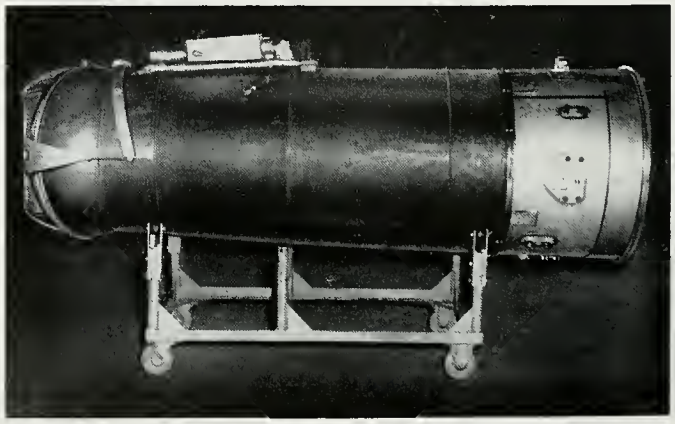
Although refined and improved, the "eye-lids" of the present General Electric afterburner display their Ryan parentage.

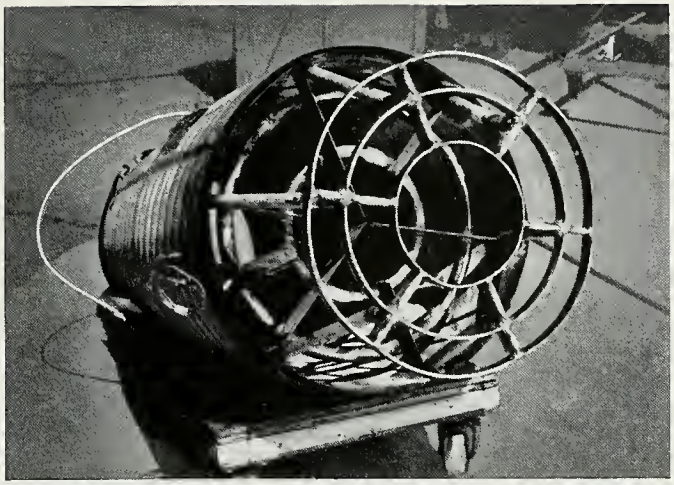
EVOLUTION OF THE

Early vintage Ryan afterburner exhibits suppart brackets and "eye-lids" but does nat yet have yake cantral arrangement.

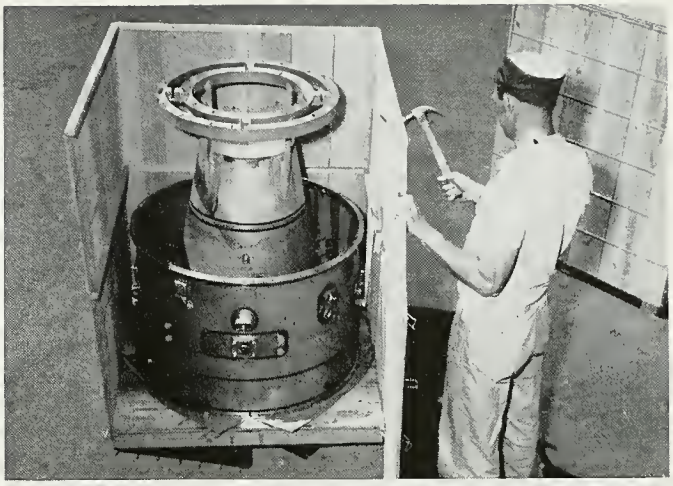


Up-ta-date General Electric afterburner incorparates yoke assembly, autamatic nazzle and cantilever suspensian design.





Nine years ago, Ryan slowed jet stream gases to burn added fuel in them by means of this ringed flameholding device.



Latest afterburner cone, being boxed for shipment from Ryan, displays a similar flameholder which uses V-shaped rings.

Ryan research created a family resemblance

VIVID testimonial to Ryan's pioneering in afterburner design may be gleaned by a glance at a modern General Electric afterburner. A striking resemblance exists between many vital components of this powerful thrust booster of today and early models which Ryan developed as far back as 1945.

Nine years is a long time in the evolution of the jet engine afterburner. The first model built in America, by N.A.C.A., would be only ten years old if it were still in existence. Planes and power plants have changed mightily in design in this interim.

Back in 1945, swept-wing air-craft were a wind-tunnel curiosity. Delta-winged planes and turboprop engines had not yet flown. The British had just captured the world's speed record by clocking 606 m.p.h. in a Gloster Meteor and the sonic barrier was a fearsome mystery.

Then, all English jet engines were centrifugal compressor types and combustion chambers were individual units. Now, annular chambers and axial flow compressors have slimmed the bulging contours of the turbojet and many design features have been changed. Today's mighty J-57 looks little like yesterday's I-40.

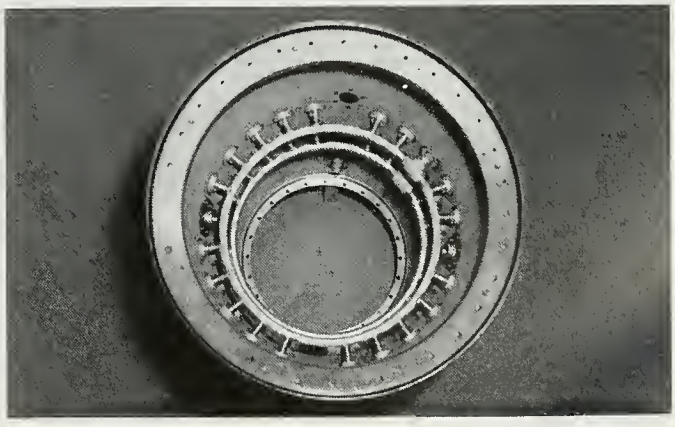
But today's afterburners employ many of the same basic design features which distinguished early Ryan models of 1945. Methods for injecting fuel, centering

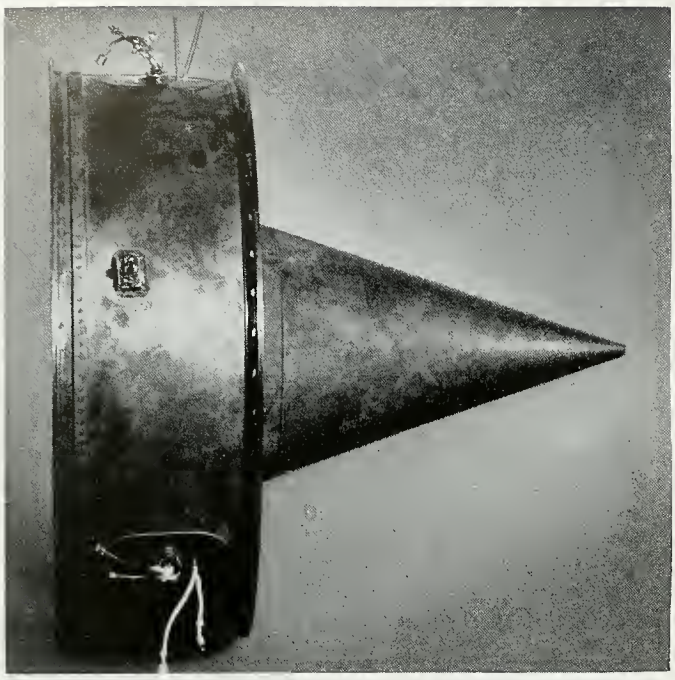
(Continued on Next Page)

AFTERBURNER

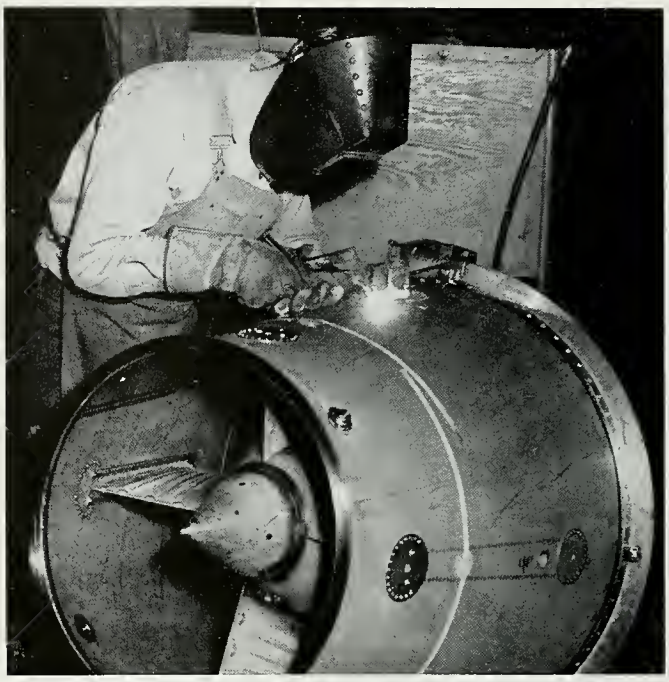
Pioneering fuel injection system for afterburners was this Ryan grid-type burner which sprayed fuel into the hot gases.

Improved fuel injection system of today utilizes many more orifices. Afterburners consume more fuel than jet engines.





Inner exhaust cone of 1945 was Ryan method for enlarging of cross-sectional area to expand and decelerate exhaust gases.



Turbojet exhaust sections built by Ryan today contain cone which is counterpart of early model, used for same purpose.

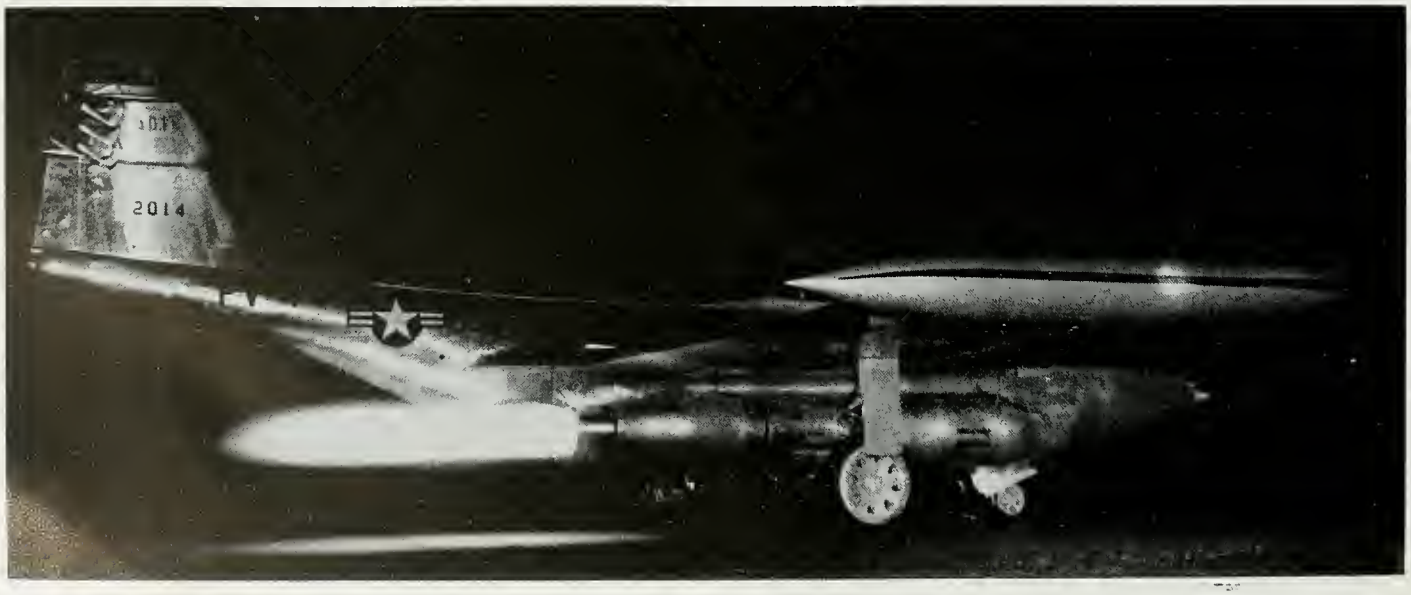
flames, controlling exit area and decelerating jet stream are fundamentally similar.

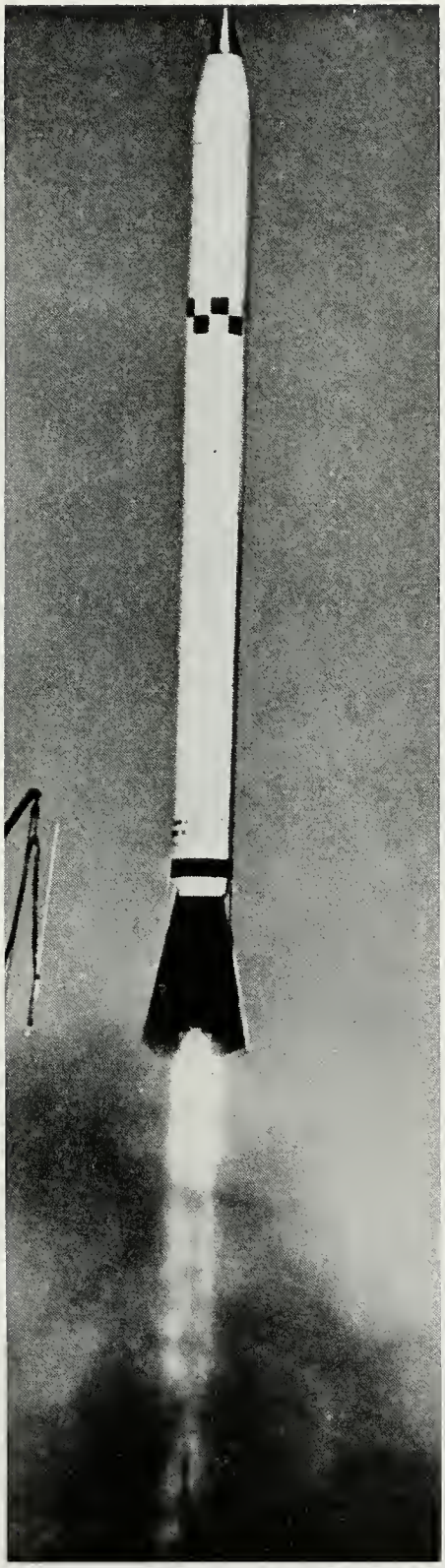
This fact underlines the awareness of Ryan engineers who designed and built the first afterburner constructed by a commercial firm in this country. In those early days, afterburners were cloaked in military secrecy and research groups worked pretty much on their own. A variety of techniques were considered for meeting the needs of afterburning.

For instance, at least five types of mechanisms could have been used to control nozzle exit area. These were flap, plug, "eye-lid," three-segment and iris. Each method accomplished a satisfactory alteration of nozzle exit area. But subsequent experience has validated the advantages of the "eye-lid" type of closure, which Ryan pioneered. It provides a large area change ratio, mechanical design is simpler, actuating forces are low and it lends itself to fabrication.

Ryan has continued to devote concentrated effort to the development of improved high temperature structures. Today, one out of every eight employees is in the engineering department and a goodly proportion of their work is concerned with jet engine research and the problems encountered in high-speed, jet propelled flight.

Bolts of flame, 15 feet long, lash out from the engines of a Northrop F-89 Scorpion when afterburners are switched into action.





Like a huge exploding pencil, poised in space, the Army's "Corporal" takes off on its supersonic flight. A shaft of fire shoots from its Ryan rocket motor.

MISSILE USES RYAN ROCKET

"Corporal" atomic missile is powered by Ryan-built rocket motor

ONE of the U. S. Army's newest atomic weapons — the "Corporal" guided missile—is powered by Ryan-built rocket motors. In a recent news dispatch, the Department of Defense revealed this deadly surface-to-surface weapon which is designed to give field commanders far greater firepower on the battlefield.

Capable of carrying either atomic or high explosive warheads, the "Corporal" flashes skyward, vertically, from a mobile launcher. It plunges through space at several times the speed of sound. Its long range enables it to strike selected targets deep in enemy rear areas—far beyond the 20-mile range of the Army's 280-mm. atomic cannon.

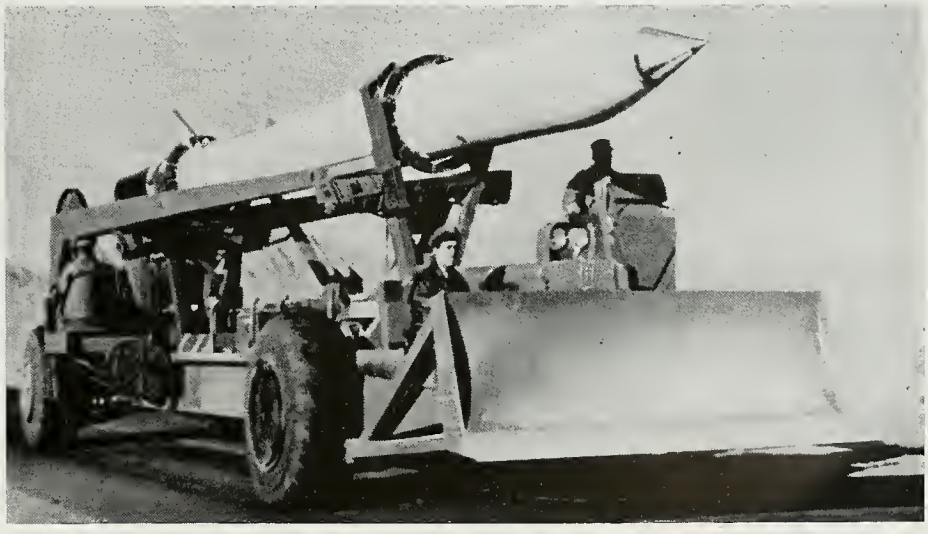
The powerful rocket motor for the "Corporal" was designed by the Jet Propulsion Laboratory of the California Institute of Technology. Ryan has built these jet power plants since the early stages of initial development. First orders were received several years ago from Douglas Aircraft Company which was then building the surface-to-surface missiles. Currently, Ryan builds the rocket motors for Firestone Tire and Rubber Company which holds the prime contract for volume production of the guided missiles. Since the beginning of the project, Ryan has received continuing increases in the production of the "Corporal" power plant.

To confine the tremendous but short-lived thrust of the powerful rocket motors, Ryan employs extremely heavy-gauge materials and new forming and welding techniques in their manufacture. The engine consumes vast quantities of fuel and oxidizer, creating terrific internal pressures.

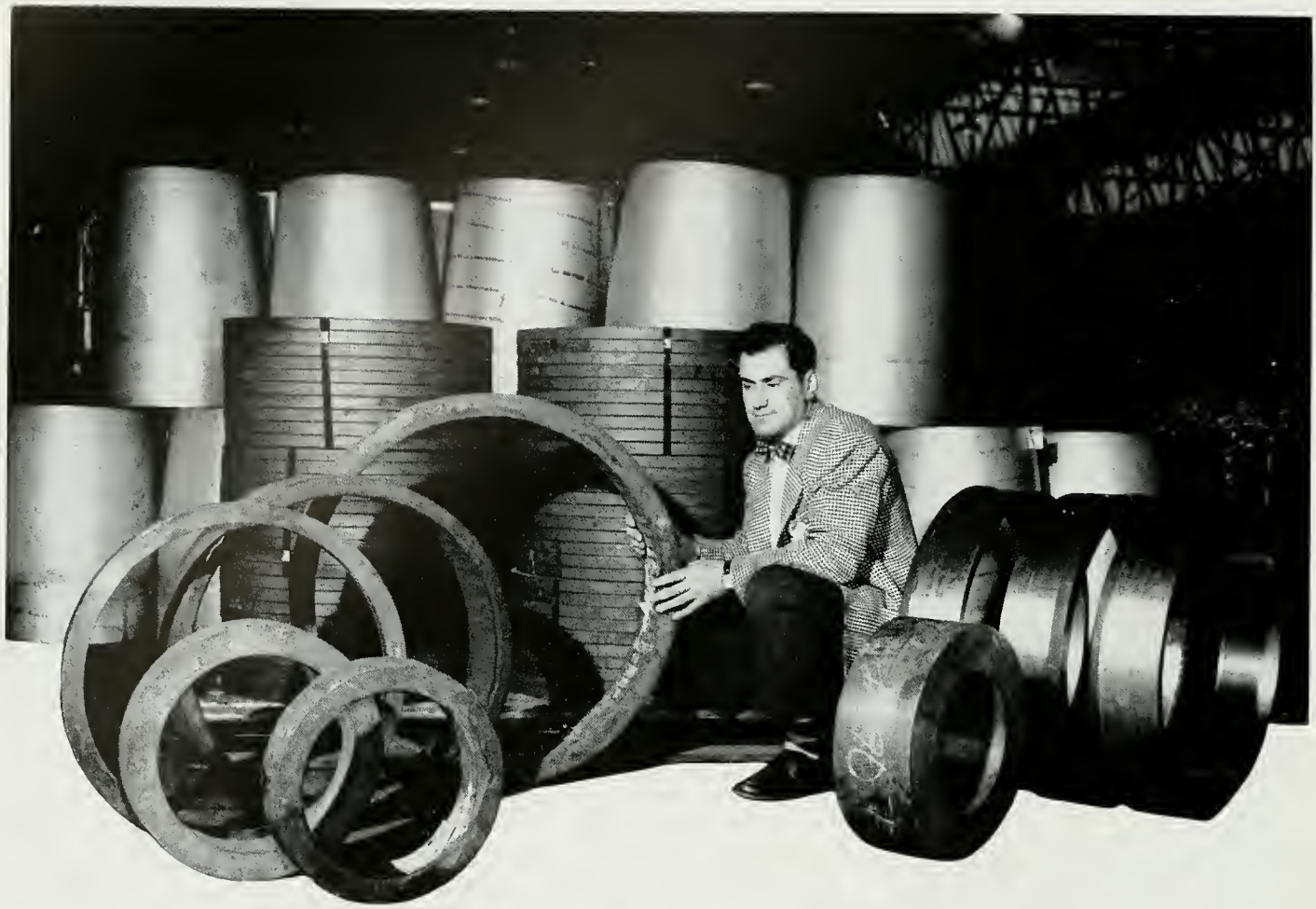
The outer shell and other sheet metal portions of the power plant must be formed to very close dimensions. Electric resistance and arc welding processes, as well as furnace brazing, are used to join the various components. Certain major assemblies must be precision-machined from stainless steel billets.

Long experienced in building the "hot end" of jet and piston engines, Ryan has further expanded the scope of its interest in the rocket field as a result of the "Corporal" missile motors contracts.

Defense Department Photos from United Press



"Corporal" is transported and erected for firing by this mobile vehicle which is shown at White Sands Proving Ground. Deliveries now being made to troops.



JET RINGS

A dozen high temperature alloy rings are used in Ryan-made aft frames to hold combustion chambers and engine bearings.

Jet engine production ha

JET engines are wedded to rings. From nose cowl to exit nozzle, these power plants are circular, sheet metal affairs strung with bands of stainless steel. The gleaming rings bolt combustion chambers, turbine cases, exhaust cones, tailpipes, afterburners and case weldments together. They also serve as housings for bearings and structural bands to reinforce assemblies.

To feed jet engine production lines, Ryan buys thousands of rings at a time. Running from 5 to 42 inches in diameter, these stainless steel components cost almost a million dollars a year. Some of them weigh as much as 350 pounds each. They are precision-machined by Ryan and welded to jet engine assemblies.

Called upon to sustain severe structural loads and intense temperatures, the

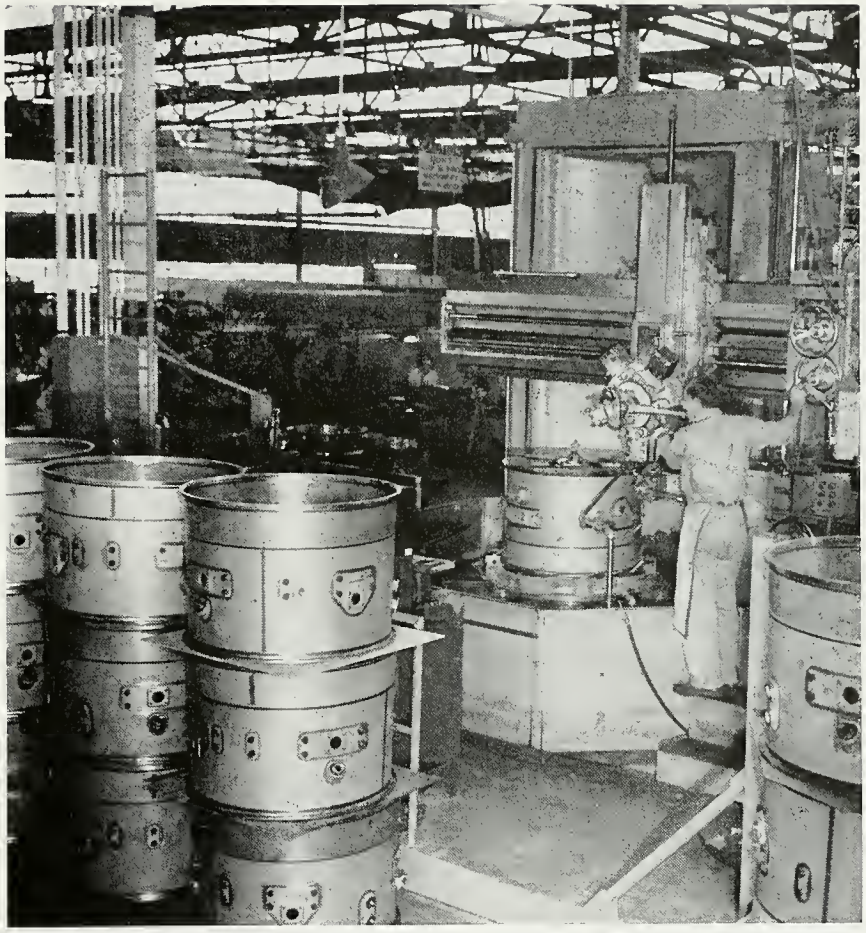
rings must be tops in quality. Their cost is commensurately high. But, through concentrated application by Ryan's Outside Production Department and excellent development work on the part of suppliers, these costs have been substantially reduced. By taking advantage of improved fabrication techniques, Ryan is saving thousands of dollars a month.

Rings are purchased from American Welding and Manufacturing Company, Dresser Industries, Inc., and Taylor Pipe and Forge Company. These concerns specialize in ring building methods of superior economic advantage. One of the largest flash-welded, stainless steel rings known, having a cross-sectional area of 11.7 square inches, is being produced to meet Ryan needs.

Because the rings which go into jet engine structures form mating surfaces, they must be machined to exact dimensions. Most are flange-type rings, with "L"-shaped cross-section. They are machined to plus or minus .005" outside and inside diameters and 63 microinch surface finish.

There are a number of ways to purchase stock for these rings. But, the costs vary greatly and that's where Outside Production performs a valuable function. They can be bought as cast sleeves and machined to size. They may be purchased as forged sleeves. Or, rolled bars

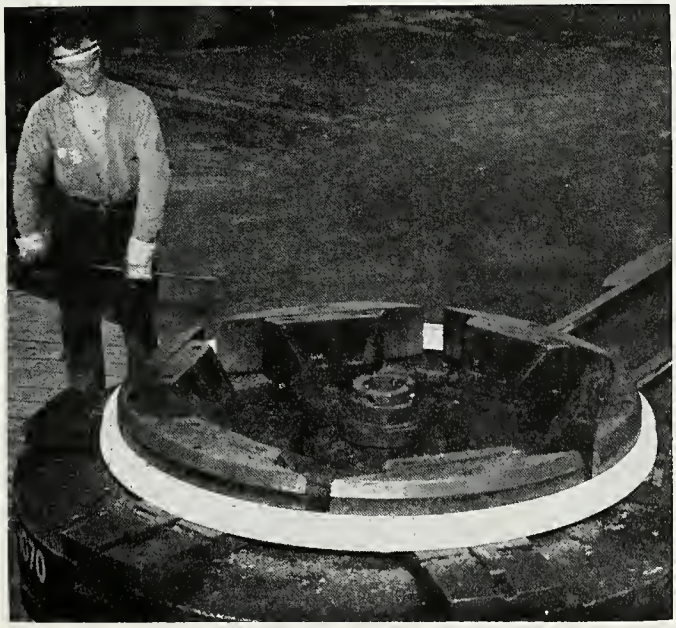
(Continued on Page 26)

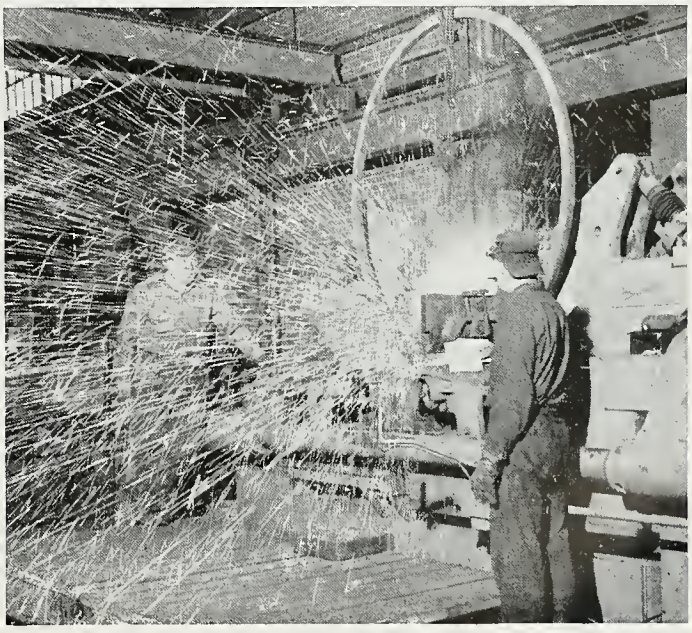


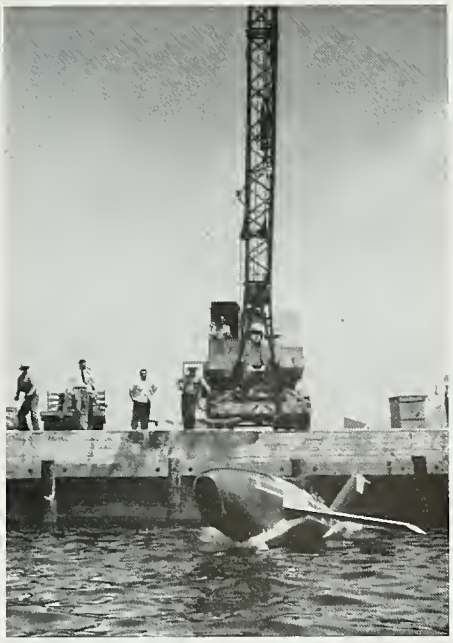
Cut from large diameter, stainless steel rings, these flanges for afterburner cones are machined in Bullard vertical turret lathes at Ryan. They must have 63 microinch finish with diameters which are within plus or minus .005 inches.

...an thinking in circles

(Left) Gleaming white-hot from the furnace, a flash butt welded ring is sized to exact dimensions on a powerful expanding mandrel at American Welding and Manufacturing Company. (Right) In a shower of scintillating sparks, Dresser Industries, Inc., flash butt welds a large ring into a strong, continuous unit.







Firebee splashes into water following six foot drop. Fall simulates 20-ft.-per-second impact occurring in parachute recovery.

WELL known in aviation circles for its near-sonic, ground-controlled antics in the air, the Ryan Firebee pilotless jet target plane has now taken to a new element—water—in recent tests conducted by Ryan engineers at the U. S. Naval Station, San Diego, California.

While it compares somewhat more favorably with a bird than with a fish, the Firebee has nevertheless proved that, not unlike the much-publicized product of a well-known soap company, it, too, can float.

The buoyancy characteristics of the "bird" are of more than passing interest to the U. S. Navy. With an undisclosed quantity of the high-speed aerial targets on order, the Navy is evaluating the Firebee for specific Navy use in the extensive flight test program now getting underway at the Naval Air Missile Test Center, Point Mugu, California.

Assisting the Naval Air Missile Test Center (NAMTC) in this evaluation is a group of 12 Ryan engineers and technicians headed by Ronald A. Reasoner, assistant project engineer. The Ryan group conducted the detailed preliminary work preparatory to actual flight tests and will continue to work closely with NAMTC during the entire program.

The Navy version of the Firebee, designated the KDA-1, is now in production at Ryan. Since virtually all of the KDA-1 flights will be conducted over water, special flotation features are incorporated in this model to insure recovery of the targets after they have been parachuted into the sea.

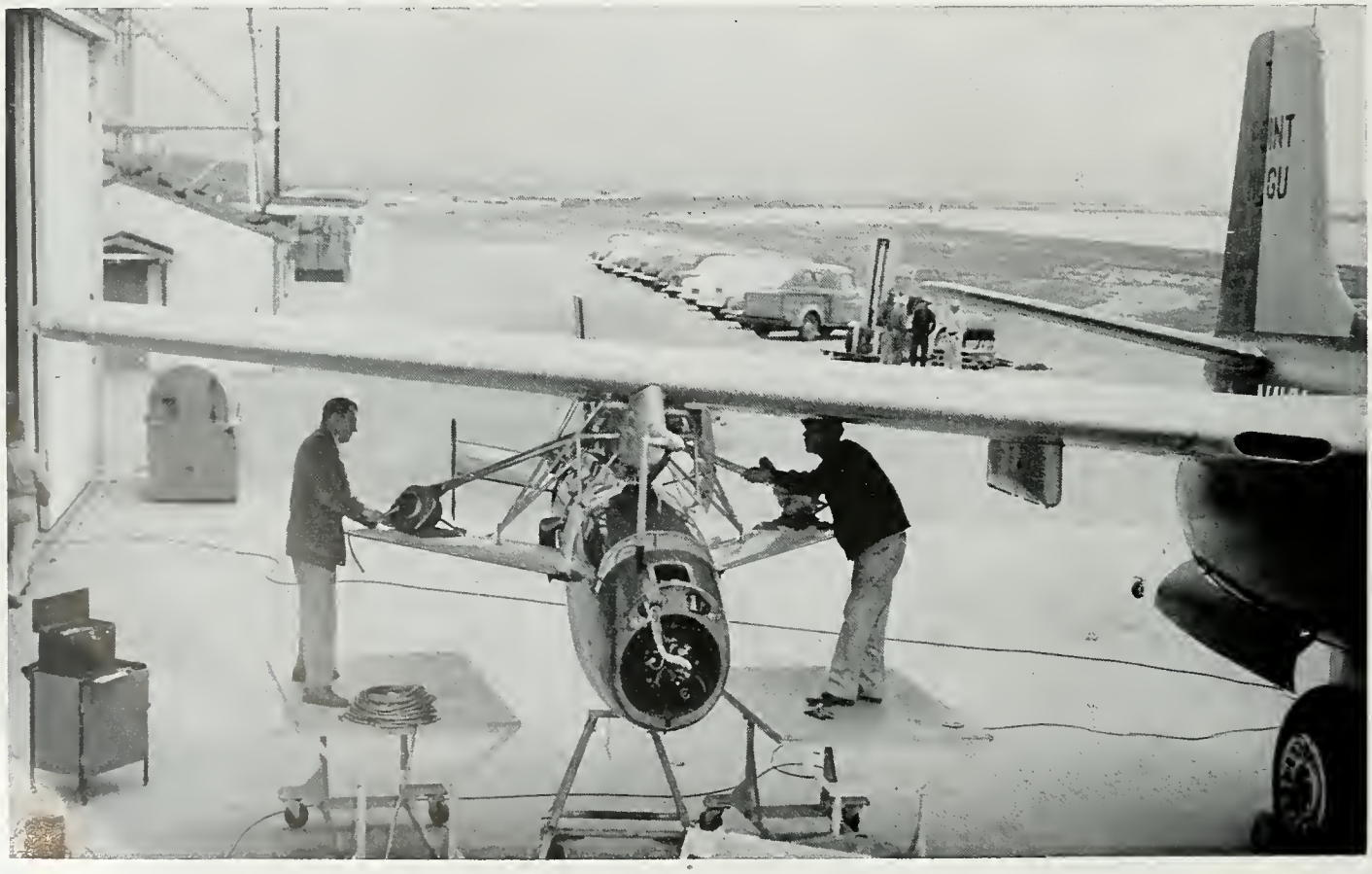
It became readily apparent in the initial

Sea-going versions of the "bird" hit the drink at Pt. Mugu

From Firebees to Seabees

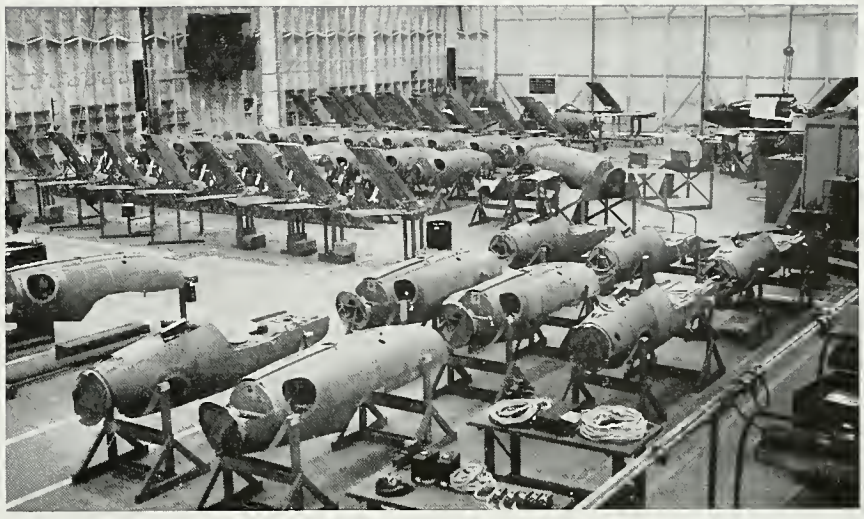
Ryan employees hoist Firebee into position in wing rack of launch plane at the Naval Air Missile Test Center, Pt. Mugu, California.

OFFICIAL UNITED STATES NAVY PHOTOGRAPH



OFFICIAL UNITED STATES NAVY PHOTOGRAPH

A. L. Burger and L. E. Sprunger make final adjustments to Firebee prior to hoisting it to the wing launch rack of launching plane. (Right) Firebees for Air Force, Army and Navy are produced in quantity at Ryan.



phases of the Firebee development program that, with the increased potential use of the target plane over ocean areas, it would be necessary to provide the "bird" with more buoyancy. Ryan engineers tackled the problem, establishing a design goal of one hour of flotation at the 50 per cent fuel condition. Navy specifications call for one hour flotation at the 25 per cent fuel condition.

A preliminary study of the flotation requirements indicated the need for approximately 500 pounds of additional buoyancy. Under consideration were various means of attaining this buoyancy, such as sealing off compartments, adding light-weight flotation material, or adding flotation bags.

Ryan engineers elected to install foamed-in-place plastic flotation material in the wings, horizontal stabilizer and nacelle. Because of the quantity of unsealed electronic equipment in the instrument equipment compartment, it was decided to seal this compartment to prevent water entry.

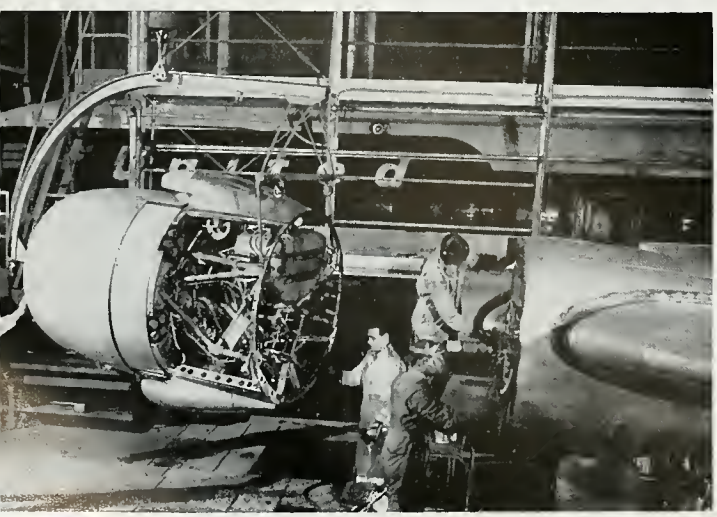
Following the Ryan engineering labora-

(Continued on Page 28)

Streams of salt water pour from the flotation-equipped Firebee as it is removed from the water after floating for sixty minutes.

MAINLI

Restored to virtually new condition, an 18-cylinder Pratt & Whitney engine is hoisted into position on a Mainliner wing.



One of America's most efficient airliners, a United DC-6 Mainliner flies eastward from San Francisco at 300 miles an hour.

THE sinews of an air line are fast, efficient aircraft and experienced crews to fly them. United Air Lines has both. With 160 modern airliners manned by 1200 pilots, 290 engineers and 820 stewardesses, United possesses one of the world's top air transport teams.

United maintains its standard of excellence by scrupulous attention to both planes and personnel. A full medical staff safeguards the health of flight personnel on a systematic basis. For the "health" of its flying equipment, United has one of the most elaborate, mechanized maintenance bases that ever awed a mechanic.

Located on a 116-acre site near San Francisco's municipal airport, this "push-button" plant contains every technical device needed to keep United's Mainliner fleet in factory-new fitness. A steady stream of 22 Mainliners a month pours through its portals from the airline's 13,250-mile network. These include Boeing Stratocruisers, Convair 340's and Douglas DC-6's, DC-6B's, DC-4's and DC-3's, all of which are equipped with Ryan exhaust systems.

Within its expansive walls, eight four-engined aircraft can be overhauled at one time. Here, 2700 skilled mechanics and technicians, an unseen contingent of United's 13,000 employees, dismantle, overhaul and assemble each Mainliner on an average of once every five months.

(Continued on Page 25)

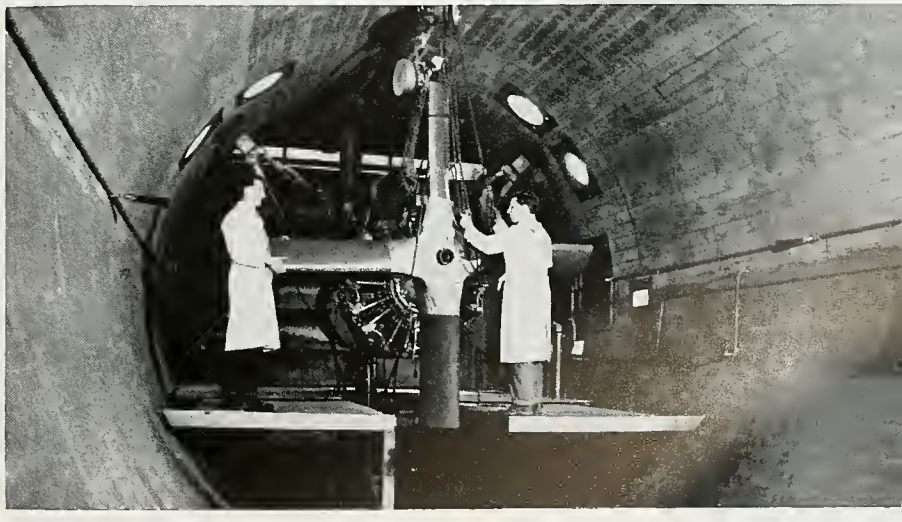
Boeing Stratacruiser engines are given a final check by United mechanics after overhaul. Ryan exhaust systems serve these 28-cylinder power plants.

NER CLINIC

United's overhaul base keeps Mainliners "factory-fit"

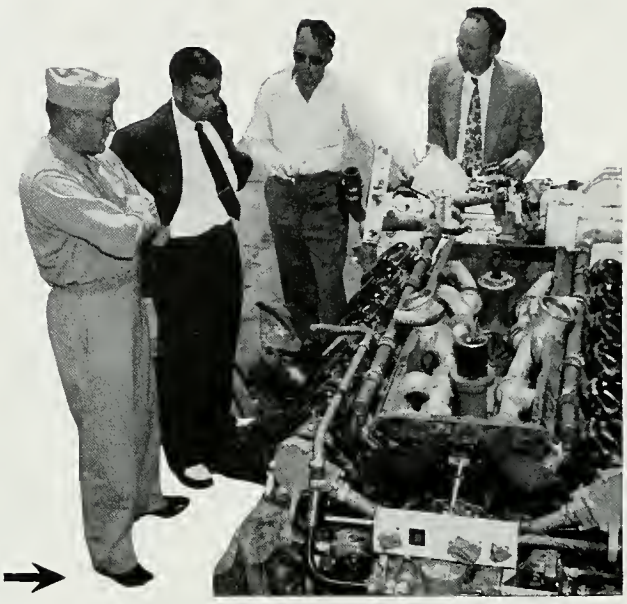
Ryan exhaust systems for Douglas DC-6 Mainliners pioneered use of jet thrust from exhaust gases.

Renewed Mainliner engines are given a shakedown "cruise" in this test cell. Heating and refrigeration simulate actual temperature ranges met in flight.



MARINE AMTRAC ENGINE USES RYAN EXHAUSTS

Already on land and in air Ryan exhausts get sea duty



Camp Pendleton Marines get service data on Ryan LTVP-5 manifolds

RYAN exhaust systems are serving with the Marines. They are standard equipment on a new combat vehicle designed to deliver the Marine Corps' hard-hitting punch on amphibious landings. This is the LTVP-5 armored assault vehicle which can operate with excellent facility on either land or sea.

Patterned after the World War II LTV (Landing Vehicle Tracked) which put thousands of Marines ashore over treacherous Pacific reefs, the new version possesses greater speed, range and maneuverability. Manned by a crew of three, the "amtrac" can hit the beach in record time with more than two squads of combat-ready Marines.

PHOTO BY PHILIPPE HALSMAN

Two squads of combat-ready Marines pour from the new LTVP-5 amphibious assault vehicle as it hits the beach during air-ground maneuvers at Quantico, Virginia.

Ryan builds thousands of the rugged stainless steel exhaust systems which serve the 810 horsepower Continental engines that power these and other military vehicles. A supercharged version of this same power plant develops 1040 horsepower.

The LTVP-5 is the latest in the parade of specialized combat vehicles for which Ryan exhaust equipment is specified. For several years, Ryan exhaust systems have been fitted to the engines of General Patton M-46, M-47 and M-48 medium tanks, developed by the Ordnance Corps, Department of the Army.

Other Ordnance Corps vehicles using Ryan high temperature equipment are the versatile T-51 Tank Retriever and T18-E-1 armored infantry carrier. The T-51 is a tracked, 14-wheel heavy vehicle which is announced as the first unit of its type capable of recovering heavy, expensive equipment in the field. It weighs 105,-000 pounds and carries its own lifting crane.

The T18-E-1 is a steel-clad personnel carrier which can convoy twelve infantrymen through enemy fire at 35-miles per hour speeds. It is also a fully-tracked machine conceived as a means for speedily bringing troops through holes in enemy lines which have been smashed by tanks.

All of these vehicles, as well as a number of others, are powered by a unique family of engines. Developed by Continental and the Ordnance Corps, these power plants are an efficient, standardized solution to many of the problems encountered with World War II military vehicles. Their design incorporates a

(Continued on Page 23)

PLANE PARADE

Ryan's thirty-two year history is rich in aviation "firsts"

Rows of Ryan-built PT-22's stretch into the distance at one of the three Ryan School of Aeronautics wartime primary training bases.

THE story of Ryan is one of broad diversification, with major pioneering contributions to many of the related fields of aviation. Ryan activities today and in the past thirty-two years reflect interest in piloted and pilotless military aircraft, personal planes, basic aeronautical research and development, scheduled air transportation, training, rocket engines, high temperature metallurgy, airframe components manufacture and many other fields.

Of these, perhaps Ryan's most outstanding—and favorite—role is that of aircraft manufacturer. In this capacity, Ryan has contributed many aviation "firsts"—some of which are presented on the following pages.

It all began in the early twenties when T. Claude Ryan, the young owner of a small but flourishing flying service, decided to expand his flying equipment from a JN4-D "Jenny" to a fleet of six war-surplus Standard biplanes. He converted these open-cockpit, two-place airplanes into five-place enclosed cabin "transports" and used them in his newly established "Los Angeles-San Diego Air Line," the first regularly scheduled year 'round passenger airline in the United States.

The "Dragonfly" observation plane could take off and land at very steep angles.

These early Ryan-Standards marked Ryan's entry into the aircraft manufacturing field. For several years an important segment of Ryan's business was buying surplus, or used, planes and remodeling them to good operating standards to satisfy the wishes of private owners.

The first strictly Ryan creation was the M-1, a spectacularly successful monoplane designed for the air mail service and destined to become the first volume production monoplane in America. In the first year of quantity production, 23 were turned out—a remarkable number of commercial planes for any factory in the 1920's.

Well established in the transport field, the M-1 was constantly improved. Its successors included the M-2 "Bluebird," first of the Ryan Broughams. The latter were to pioneer air line routes in Latin America, Canada and Alaska, as well as in the United States. The Brougham had

(Continued on Page 16)

GENEALOGY OF

NAVION
COMMERCIAL
OBSERVATION
YO-51 DRAGONFLY
FR-1 FIREBALL
FIGHTERS
XF2R-1 (RESEARCH)
XFR-4 (RESEARCH)
CLASSIFIED
1955
1950
1945
1940
PILOTLESS
FIREBIRD
FIREBEE
L-17B
LIAISON
MODEL 72
TRAINER
STM
PT-20
PT-20A
STM-S2
PT-22
PT-25
TRAINERS
RYAN AIRCRAFT

Ryan "Fireball" was first plane in world with prop-plus-jet powerplant combination.

First volume production monoplane in the United States was the Ryan M-1 mail plane.

another distinction—it provided the basis for the design of Lindbergh's "Spirit of St. Louis," built in the Ryan Airlines, Inc. plant for the now-famous airmail pilot who was attracted by the renown of the Ryan mail planes.

In the early thirties Ryan developed what was to become the country's outstanding sport-trainer. Designated the S-T, this low-wing, metal fuselaged, 2-place plane set acrobatic and efficiency records throughout the world. By 1935, the S-T's were so popular that they were being turned out of the Ryan factory at Lindbergh Field on what was then considered virtually a production line basis.

From the open cockpit S-T, the development of the enclosed S-C was a logical step forward. Produced late in 1937, the S-C metal cabin plane was the first private owner type which took full advantage of modern metal construction features and full cantilever low-wing streamlined efficiency.

Prior to the United States' entrance into World War II, Ryan, with a military version of its 125 h.p. STA, won a design competition for a military trainer. In the Ryan PT-16, the Army got its first low-wing primary trainer, which was a major departure from a 30-year precedent of using only biplanes for initial instruction of aviation cadets.

This early model and the PT-20's were followed by the best known of the PT's, the PT-22 Recruit, of which more than a thousand were built for primary training of aviation cadets. Many of the Ryan PT's were utilized by the Ryan School of Aeronautics located in San Diego and Hemet, California, and Tucson, Arizona in training more than 14,000 pilots during the war years.

Export versions of the PT-20's, known as STM's, were shipped overseas in 1940 and 1941 for use by the Chinese Air Force and Netherlands East Indies Air Force. Another model, the STM-S2 seaplane trainer with twin floats, was developed and supplied to the Dutch East Indies Navy.

Because of the critical aluminum supply in 1942, the Army asked Ryan to develop an entirely new trainer—a plywood plane making minimum use of metals. The two-place open cockpit PT-25 was an entirely new military airplane in design, construction and materials. Aluminum alloys and all strategic materials were almost entirely eliminated, with the exception of the engine cowling which represented less than two per cent of the total weight of the airframe.

Another assignment from the U. S. Army was for the development and limited production of an experimental short-range liaison observation plane. This resulted in the Ryan YO-51 "Dragonfly,"

Rocket-powered Ryan XAAM-A-1 "Firebird" was the first air-to-air guided missile announced by the United States Air Force.

which was capable of virtually hovering in flight. With slots along the entire leading edge and a Fowler-type flap along the entire length of the trailing edge, the Dragonfly was able to take off and clear a fifty-foot obstacle within 350 feet, and could maintain a minimum flight speed of 32 miles an hour while holding a chosen altitude. It could land almost in its own length.

In late 1942, the Navy Bureau of Aeronautics asked Ryan to design and produce the FR-1, a new combat plane which would combine the advantages of both piston engine and jet power plant in a single configuration.

The Ryan Fireball was not only the first plane in the world to combine reciprocating engine power with jet propulsion, but was also the Navy's first jet airplane, thereby pioneering the use of jet aircraft on carriers. Of almost equal importance, it was the first tricycle-geared aircraft qualified for carrier operations.

To enable Navy pilots to fly efficiently on the jet engine alone, the Fireball was equipped with first full-feathering propeller used on single piston-engined aircraft. The original Fireball was powered with a 1300 horsepower Wright Cyclone R-1820 piston engine turning a propeller, and a 1600-pound thrust General Electric I-16 jet engine in the aft fuselage.

A later version of the Fireball series, the XF2R-1 Dark Shark, substituted a General Electric TG-100 turbo-prop engine for the forward piston-type power plant. This was the Navy's first turbo-prop airplane and the first turbo-prop-powered airplane to make a cross-country flight. Still another version was the XFR-4 with the first flush-entry ducts; and using a Westinghouse 24-C as the aft engine.

After World War II, the Ryan organization returned to one of its first loves in aviation—the private plane field—with acquisition of the design and manufacturing rights of the Navion from North American Aviation, Inc. Refinements, based on the company's long knowledge of safety and reliability features wanted by private owners, were immediately incorporated, and the big, rugged, fast, safe and easy-to-fly Ryan Navion found rapidly increasing favor.

The L-17B liaison plane, a military version of the four-place, all-metal commercial Ryan Navion, saw extensive service in Korea. Procured "off-the-shelf" with no special expenditure for new design, the L-17B's proved their ability to perform light transport missions, aerial reconnaissance, artillery spotting, fighter plane target direction and the transport of field commanders.

In 1949, Ryan completed successful research on the first air-to-air guided missile for the Air Force. The result of more than two years flight testing, this 10-foot-long, rocket-propelled projectile was designated the Ryan XAAM-A-1 "Firebird." It was designed to track enemy aircraft by means of complex radar navigation and electronic systems.

The Ryan STM military trainer was adopted by many foreign countries. Large numbers were exported to Netherlands East Indies.

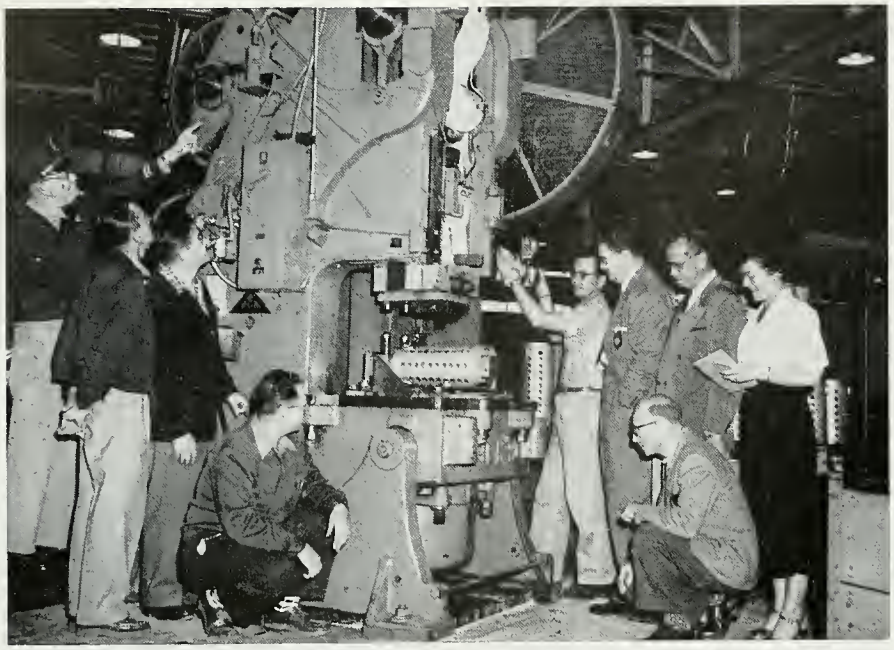
Shortly after the completion of the Firebird experimental project, Ryan developed the Firebee pilotless jet target drone under the joint sponsorship of the Air Force, Army and Navy. Designed for anti-aircraft and aerial gunnery training, for use in combat plane interception problems and in guided missile target work, the Ryan Firebee is a mid-wing, all-metal pilotless aircraft with sharply swept-back wings and tail surfaces. Power plant is either a Fairchild J-44 or Continental-Marbore J-69; both of approximately 1000 pounds thrust.

The remote-controlled Firebee is capable of near-sonic speeds and has performance characteristics similar to those of current American jet fighter aircraft. It can be launched either from the ground or in the air from a "mother" plane. At the end of each flight the target drones are recovered by a self-contained two-stage parachute which permits the repeated use of the Firebees.

Ryan recently introduced a new approach to the primary training of military pilots with the "Model 72" side-by-side primary trainer. Based on the highly practical advantages of having the instructor and student seated side-by-side rather than in the conventional "fore and aft" tandem arrangement, the Model 72 is a commercial Ryan Navion redesigned to military training standards.

In its present role as a Weapons System Contractor for the U. S. Government, Ryan continues to enlarge the scope of its research and development effort to keep pace with and contribute to the technological advances in the field of aviation. With work underway on many new and challenging projects, Ryan engineers are looking ahead to the development of still more revolutionary Ryan aircraft to carry on a proud tradition.

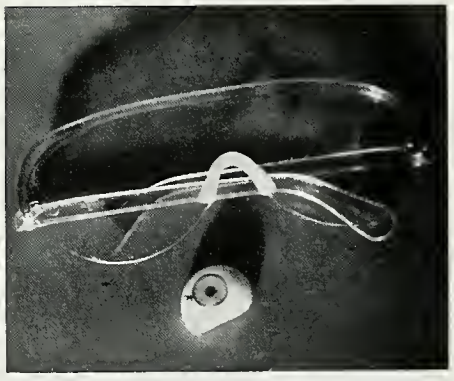
The military Ryan Navion L-17B liaison plane saw extensive service in Korea where it was used for spotting, reconnaissance and light transport missions.



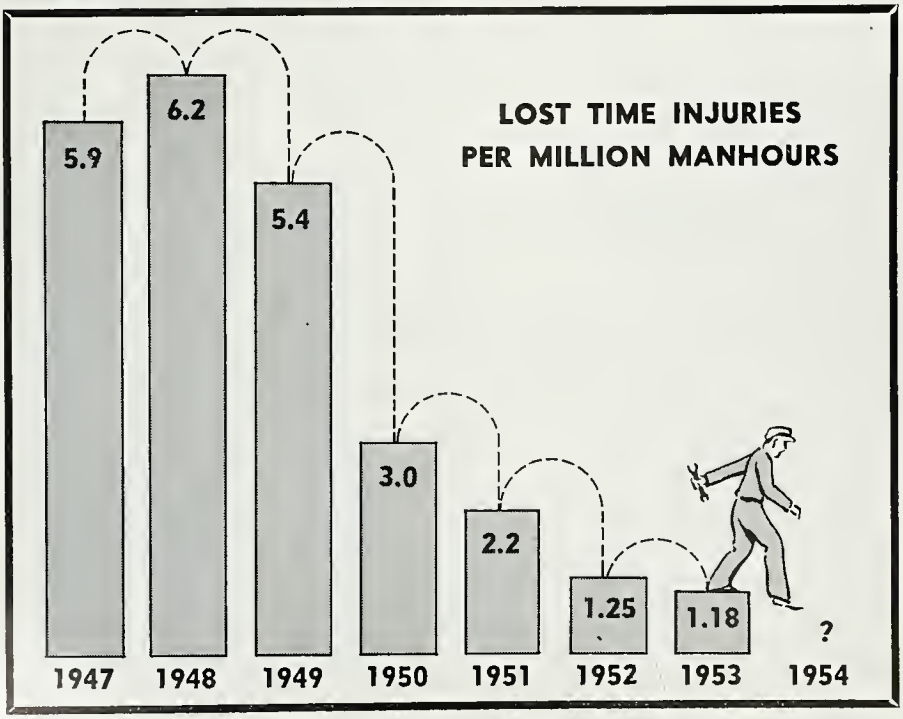
A supervisors' safety committee checks working habits of punch press operator and inspects machine in periodic tour of Ryan plant to guard against unsafe conditions.

Tomfoolery may lead to serious injuries, as this posed picture, used in accident prevention program at Ryan, demonstrates.

Jet assembly department, which once had greatest number of eye injuries at Ryan, had none in 1953. Foreman Ray Jaeger watches spotweld operator, Jim Pocinich, properly fitted with safety glasses, at machine.



Momentary failure to use safety glasses resulted in eye injury to worker. Plastic replica of an eye is used by Ryan safety engineers to show where drill bit sliver entered, dramatizing constant hazard.



Constant diligence on the "Safety" theme produces a record like this.

Injuries decreased sharply after Ryan launched its new system of . . .

INSURING SAFETY

The time-honored axiom, "An ounce of prevention is worth a pound of cure," applies most vividly to an industrial plant, where machines that exert great force create, by the very nature of their operation, hazards which must be controlled by systematic safeguards.

Only rarely these days does a machine fail in an unpredictable manner, resulting in injuries that might be classified unavoidable. These instances are comparatively so infrequent — the National Safety Council and the U. S. Department of Labor point out—that the overwhelming majority of accidents, over 95 per cent, are attributable to human failure. The ounce of prevention in industry is aimed at protecting the worker against his own tendency toward carelessness. Modern safety engineering, with all its mechanical safeguards, thus becomes mainly "human engineering."

Safety engineering is not an intangible art. It pays off, not only in lives and limbs saved, but in dollars and cents to company management. And when the cost of industrial accidents is borne directly by the company, instead of by an outside insurance carrier, the motivations toward improved safety become sharply impelling. This has been graphically illustrated at Ryan Aeronautical Company.

A rising curve of "lost-time" accidents became a matter of special concern when it reached a peak in 1948 and 1949. In-

(Continued on Page 22)

How it feels to be blinded by an industriol accident is brought home to supervisory employees blindfolded in safety meeting at Ryan.

In cavernous concrete test cells, Westinghouse shakes down new turbojets with little handling. Engines are tested in final assembly dollies rigged to transmit test data.

IN AMERICA'S vast storehouse of ideas, skills and production know-how that have combined to create some of the world's most potent jet engines, Westinghouse Electric Corporation has an extensive leasehold.

The nation's stockpile of engineering and manufacturing techniques can be attributed in great measure to Westinghouse's pioneering efforts on the first "native" jet engine, dating back to 1941.

At a time when England's leadership in centrifugal flow compressor engines was unchallenged, Westinghouse carved a new path by designing the first American axial flow compressor engine, providing more power in a smaller package. This was the 19-B "Yankee," used in the McDonnell plane which was the first all-jet plane to operate successfully from American aircraft carriers.

Since then, Westinghouse has forged increasingly powerful jet engines, now given even greater thrust by afterburners such as those which Ryan is building for the mighty new J-46 engine.

Late in World War II, Westinghouse developed a tiny, 9½-inch thick "baby" jet to drive American pilotless buzz bombs. The Navy's first production all-jet carrier fighter, the McDonnell "Phantom," was powered by the J-30. Another McDonnell plane, the fast-climbing "Banshee," was powered by the J-34 engine.

A new world's speed record was set last October by the Navy's Douglas "Skyray" over a three-kilometer straightaway course. The "Skyray," powered by a

TURBOJETS by WESTINC

Westinghouse builds jets with 68 years of know-how

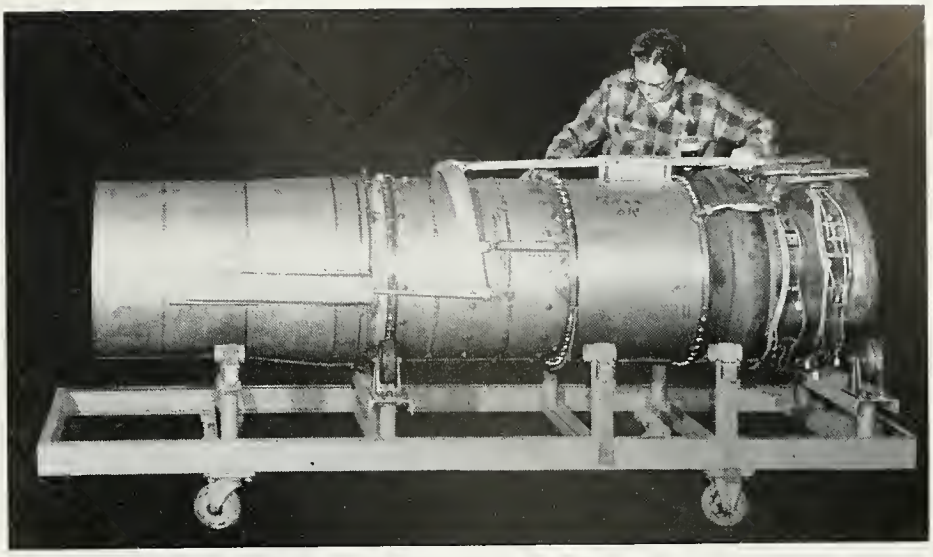
In one of the world's largest turbojet plants Westinghouse engines roll off the assembly lines. They will be "canned" in steel containers, shipped and installed in some of the Navy's fastest carrier-borne planes.

Westinghouse J-40 engine, made four consecutive runs at an average speed of 753.4 miles per hour, 16 miles per hour faster than the previous mark. The J-40 also has been installed in the revolutionary new jet seaplane, the Convair "Sea Dart," undergoing tests in San Diego.

Many other military planes have been powered with Westinghouse jets, including the Navy's F6U Chance-Vought "Pirate," the F7U Chance-Vought "Cutlass," the F3D Douglas "Sky Knight," and the D-558-II Douglas "Skyrocket;" and the Air Force's F-88 McDonnell penetration fighter "Voodoo," the F-85 McDonnell parasite "Goblin," the F-90 Lockheed penetration fighter, and the experimental Northrop X-4.

The newest Westinghouse engine, the J-46, for which Ryan is providing the extra afterburner "kick," will be first used in the new swept-wing, tailless Chance-Vought F7U-3 "Cutlass," one of the Navy's latest high-speed, carrier-based fiighters. The J-46 is the most modern example of the basic Westinghouse principle of big power in a small package. It is 16½ feet long, not quite 3 feet in diameter, and weighs approximately 2,000 pounds. The J-46 is being produced in the Westinghouse jet engine plant in Kansas City, believed to be the largest factory of its kind in the world.

Secrecy still shrouds most details of the J-46 structure and performance. However, it is described as the outgrowth of the Westinghouse J-34, a 10-foot long, 1200-pound engine which produces 3250 pounds of thrust, at a ratio of 2½ pounds of thrust for every pound of engine weight.



Nozzle actuating mechanism of a Ryan-built afterburner for the Westinghouse J-46 turbojet is checked by James Key. Ryan is in volume production of this powerful thrust booster now being installed with J-46's in Chance Vought F7U-3 Cutlasses.

At standstill, the J-34 sucks air in the front end at 25 miles an hour, and ejects it from the jet nozzle at 1200 miles an hour, in less than half a second for a given molecule of air. The compressor and turbine of the engine whirl at 12,500 R.P.M. to pack in the 100 tons of air the engine "breathes" every hour. The J-34 was the first engine to attempt and complete the grueling 150-hour Air Force-Navy qualification test, MIL-E-5009, at a time when technicians were protesting that the preformance requirements were so extreme it was considered doubtful any engine then in existence could successfully pass them.

Later, the J-46, with greatly increased

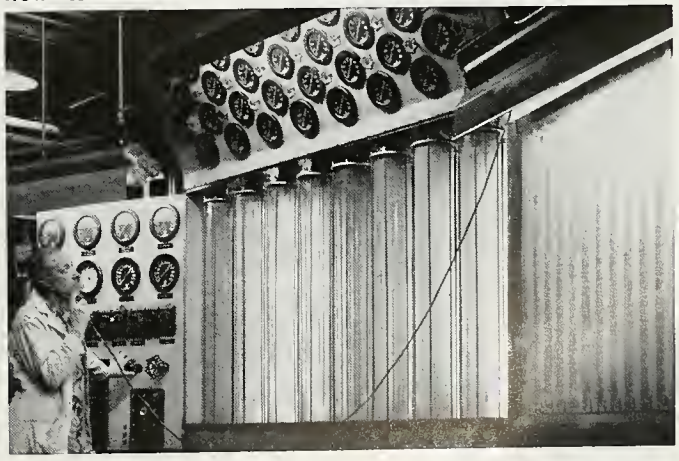
(Continued on Page 24)

Speed pilot Lt. Cdr. James Verdin and Chief Engineers Reinout Kroon (Westinghouse) and Edward Heinemann (Douglas) discuss the J-40 turbojet which powered a Douglas F4D Skyray to a world's record of 753 m.p.h. last year. Plane was first carrier type to hold the world's speed record.

IOUSE

estinghouse test engineer observes the performance of a jet engine nning in test cell. Westinghouse built first "American" turbojet.

As a jet engine howls at open throttle in test cell, fuel flow is checked with this bank of vertical glass tubes.



INSURING SAFETY

(Continued from Page 19)

surance premiums, based on experience factors, climbed sharply. The time had come for a critical appraisal of the entire safety program. As the first and major step, a "self-insurance" system was instituted. The company henceforth would directly pay expenses incurred in industrial accidents.

An adequate reserve fund was established by the company to meet requirements of the California Industrial Accident Commission, charged with the responsibility of assuring that claims are promptly met.

An outside administrator, a Los Angeles concern specializing in such work, was chosen to supervise the payment of claims, to conduct investigations beyond those which the Ryan safety engineering department was equipped to handle, and to provide the legal staff for litigation before the Industrial Accident Commission's referee on disputed cases.

Most accident cases are settled by agreement between Ryan and the employee, with Commission approval of the monetary award. The administrator, using the yardstick of past experience, proposes a settlement, which the employee can either accept or reject. If it is rejected, the Commission referee conducts a hearing, and recommends an award.

When "self-insurance" went into effect June 1, 1949, a vigorous attack on the inherent risks of factory employment was launched. The safety program was given sharp implementation, revolving around whole-hearted cooperation between supervisory personnel and employees.

The results have been remarkable. In 1948, the number of lost time injuries per million manhours worked was at an all-time high of 6.2. The payroll then contained an average of only 1746 employees, most of them old-timers with the company. In 1953, when there were more than 4350 workers, with the accompanying increased chances of accidents as swarms of new employees entered the plant, the number of lost time injuries per million manhours worked had plunged to 1.18.

The average clinic cases per month per 100 employees also dropped to a new low, .92, as against 1.60 in 1948 and 1.66 in 1949. These refer to accidents of all kinds requiring treatment by a doctor.

And the number of lost time accidents dropped from 23 in 1949 to only 11 in 1953, when employment was more than double.

How was this gratifying improvement in safety accomplished? It was not done with fanfare, flamboyant slogans or offers of prizes. It was performed by inculcating safety consciousness in all levels of employees through an unrelenting workaday routine. Because safety is basically a state of mind, Ryan tackled it as a day-in, day-out problem.

At the core of the program of accident prevention are two types of in-plant committees—supervisors' safety committees and a workman's safety committee.

The supervisors' committees each month make thorough inspections of the plant, checking on unsafe practices and the need for improved housekeeping. Tidiness and good order are ingredients of accident prevention.

Sixteen supervisors are divided into groups of four, and the four groups, on consecutive days once a month, tour different zones of the plant with Herbert E. Rawlings, safety engineer.

To bring a fresh viewpoint—to avoid the oversight which familiarity might breed—the supervisors inspect areas other than those in which they are customarily stationed. This has been found conducive to a sharply critical approach as they observe faulty equipment, improper working habits, poor housekeeping, use of personal protective equipment, and listen to complaints.

A complete record of these observations is made by a secretary who accompanies the groups, and copies of the findings are distributed to all supervision for immediate attention and action.

The infinite detail of this monthly safety and housekeeping inspection is exemplified by the entries on one such report:

"Yard and Storage Areas—Parts box full of trash rear of Automotive Service building.

"Automotive Outside Area—Carbon dioxide extinguisher recommended at Valve No. 1. Inside area—sand absorbent under compressor needs changing.

"Department A—Pedestal grinder improperly anchored. Weld booth had cardboard shields on both sides; fire hazard and clutters area.

"Department B—Employee on vertical turret lathe standing on work bench to reach work in a hazardous leaning position; also, a badly mushroomed lead hammer.

"Department C—Three instances of improper hair covering; female employee wearing long pony tail hair-do with a lightweight net.

"Department D—Cluttered under stairway. This entire area needs housekeeping; coats and sweaters hung on and over anything available. Saw blades improperly hung.

"Department E — Female employees bucking rivets and not wearing eye protection."

The safety engineering department, in

(Continued on Next Page)

Works Manager Named To Vice-Presidency

LAWRENCE M. LIMBACH
Named Vice President

Lawrence M. Limbach, Works Manager, has been elected Vice President-Manufacturing by the Ryan Board of Directors, and Donald S. Perley, Acting Controller for the past seven months, has been named Controller.

The selections were made by the Board immediately after the annual meeting of stockholders March 16. The Board, consisting of T. Claude Ryan, President; G. C. Woodard, Executive Vice President; Earl D. Prudden, Vice President; C. Arnholt Smith and Melvin H. Lockett, was re-elected. Officers of the past year were reappointed. Besides those mentioned, they include C. A. Stillwagen, Secretary and Treasurer; and Dale H. Ockerman, Assistant Secretary and Assistant Treasurer.

Limbach came to Ryan two years ago after 19 years' service with Republic Steel Corp., where his last post was Manager of Operations, Steel and Tubes Division. He started with Republic as an apprentice in 1933.

Donald S. Perley

Perley assumed his duties as Acting Controller last Sept. 1 after eight years as chief accountant of the Washburn Wire Company, Providence, R. I. and New York City, manufacturers of high grade specialty wire for the automotive and other industries.

INSURING SAFETY

(Continued from Page 22)

its follow-up, makes sure the corrections recommended are made.

In addition to the safety and housekeeping inspections, all supervisory personnel—from the vice president-manufacturing to the newest assistant foreman, attend a safety meeting once a month. Experiences of the past month that need attention are related. Techniques in dealing with employees to reduce accident-proneness — the "human engineering—are compared. Safety films provided by the National Safety Council and other organizations are shown.

Personal interest in such meetings has been promoted by appointment of a different supervisor each month to act as co-chairman, jointly responsible with the safety engineer for the success of the session. Supervisors who otherwise might have viewed these confabs as merely a necessary routine imposed by the safety department become vividly aware of the importance of the problem.

Accident prevention is not a program that can be imposed from the top down. Most industrial mishaps occur among hourly paid workers, the organization's rank and file. Their ideas on hazards and means of avoiding them are essential.

To provide another channel for such ideas, a workman's safety committee is established at Ryan, consisting of three representatives of the UAW-CIO, and the plant safety engineer. This committee tours the plant each Friday, accompanied by Rawlings or the second shift safety engineer, Charles McCauley. Written reports are also made of the findings of this committee, and once a month, these reports are reviewed, followed by recommendations of specific action.

Recently, the exchange of ideas between supervisory personnel and hourly paid employees has been enhanced further by monthly department safety meetings. These are conducted on company time, with the entire department taking ten or 15 minutes after a regular rest period to discuss methods of preventing accidents and improving housekeeping as applied to the particular conditions of their department.

Safety training of an employee starts on the day he is hired. Classification of the applicant for a work-load is based on the pre-employment physical examination which may bring to light physical conditions previously unknown even to the applicant. On his first day on the job, he is impressed with the inherent hazards if the work is not performed as instructed and if proper protective equipment is not worn or used.

Ryan is interested not only in accident prevention, but in the rehabilitation of injured employees after they are discharged from medical treatment. Every effort is made to reinstate such workers in jobs they are qualified to perform.

Maurice M. Clancy, safety and welfare supervisor, notes that a worker who has recovered from his injuries may have a unique value to the company. He cited as an example the worker who lost four fingers of his left hand while operating a punch press.

"After he recovered, we found that he could be entrusted with a more responsible job than he previously had," Clancy said. "He was, of course, handicapped in operating a machine, but we decided to place him in charge of punch press 'set-ups.'

"Today he makes sure that no one else makes the same mistake he did, as he determines that the die is fastened properly to the bed and the punch to the ram, and that all other safety measures are taken—the guard cages or safety valves in proper position."

Ryan's "self-insurance" safety program was marked during the 1953 fiscal year by a spectacular record of 128 consecutive days without a disabling or lost time injury. This was one of the top safety records for the year in U. S. industry.

High Speed Target Drones On Navy's 1955 Buying Program

Recent testimony of Rear Adm. Apollo Soucek, chief of the Navy Bureau of Aeronautics, before a House Appropriations Subcommittee regarding the proposed naval aviation procurement program for 1955 is of particular interest to the Ryan Aeronautical Company and its employees because of its prominent references to target drone projects.

"The increase in the target drone procurement area reflects the shift from 200-knot drones to drones in the 400-knot and 600-knot classes," he said.

"The 1955 estimate provides an initial quantity of a joint Service-developed high-speed, long-range target drone in the 400-knot class to supply the fleet gunnery training program with targets capable of simulating potential enemy attack from out-of-sight ranges.

(This is apparently a reference to the Ryan Firebee, which is under production here for the Navy, as well as for other Services.—Ed.)

"Fleet evaluation currently underway with these 400-knot targets is satisfactorily demonstrating their performance characteristics with respect to radar reflectivity, flight endurance, and speed. In addition, the 1955 estimate provides for the procurement of additional quantities of aircraft-size high-speed, long-range targets in the 600-knot class necessary to train fleet personnel in guided-missile operations."

It was disclosed that the Navy is asking for an increase from $9,549,970 in 1954 for target drone procurement to $15 million in 1955.

Justifying this increase, Capt. Morris A. Hirsch, director of the Bureau of Aeronautics' fiscal division, testified that it "reflects the urgent need for very high-speed drones to more adequately simulate modern aircraft performance.

"They, having a much higher speed, have a much higher unit cost than the type of drones we have been buying. The actual quantity of drones to be procured during 1955 is substantially less than in prior years. The difference is made up in the higher cost of the models being procured."

MARINE AMTRAC ENGINE

(Continued from Page 12)

large number of interchangeable parts in engines running from 375 to 1040 horsepower. This greatly simplifies service and repair operations in the field.

Another desirable feature of these engines is their light weight, with some models weighing only three pounds per horsepower. This provides military vehicles with added range, speed and maneuverability.

Ryan builds the complete exhaust system for the largest of these power plants —a 12-cylinder, V-type engine rated at 810 horsepower, or 1040 horsepower when supercharged. The Ryan exhaust equipment is fabricated on a continuous conveyor belt line from which thousands of units have flowed during recent years.

Each manifold serves six cylinders, or one bank, of the Continental engine. Made of stainless steel, the sections are formed into half-stampings, annealed, joined with inert gas shielded arc welding

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MARINE AMTRAC ENGINE

(Continued from Page 23)

and machined to high precision. Exhaust port flanges are welded on the tubes. The flanges are punched out of heavy 5/16 inch thick stainless steel by 65-ton blows of punch presses which also knock out the four small attachment bolt holes in each flange.

Four stainless steel bellows are welded into each assembly. These provide flexibility for installation purposes and accommodate thermal expansion with a water-tight joint. Engines are designed to operate under water because military vehicles are either amphibious or equipped to ford streams. After assembly, each manifold must be machined so that all six cylinder flange faces fall within a plane that is .005 inches flat.

Carburetor heat, to prevent icing conditions, is picked up from each manifold by means of a tube inserted in the hot exhaust stream. The tube end is subjected to the extremely hot flames and eroding gases which exist in the central areas of the seething gases. Cooling is not possible because the tube walls are surrounded by gases on both sides.

Tubes lasted only a short time under this withering environment until they were protected with high temperature ceramic coatings. Ryan specified a thin coating only one thousandth of an inch thick, which has extended tube life to match that of the manifold.

Because of Ryan's long experience in meeting high temperature problems associated with power plants, Ryan exhaust systems are standard equipment on a wide variety of vehicles. In addition to the combat vehicles of the Ordnance Corps, Department of the Army, Ryan equipment serves seven different types of helicopters and seven types of lighter-than-air blimps. Ryan exhaust components are also found on the sensational new gas turbine-powered truck developed by Boeing Airplane and Kenworth truck companies.

In the aircraft field, Ryan systems serve the vast majority of military and commercial transports in operation today. Nine out of ten of the different types of large transport planes flown by Military Air Transport Service (MATS) use Ryan exhaust manifolds. Ten out of twelve of the nation's large commercial airliner types are equipped with Ryan systems.

JET TEST TUBE

(Continued from Page 1)

a large 6-foot diameter pipe, leading to the silencers. In this duct, copious quantities of water will be sprayed into the flaming gases by a system which can deliver 900 gallons a minute. Water flow is automatically controlled by thermocouples which actuate a valve in the 6-inch water line. This cold shower for the hot gas brings the temperature down from 1500°F. to about 450°F. It also exerts a profound silencing effect.

Jet engines are much like fire sirens in that both are good noise makers and function by passing a stream of air through whirling blades. Cooling reduces the density of the hot gases which slows their velocity. The slower they move, the less noise they make as they "pop" into the open air. After being cooled by the water spray, the gases pass into the silencing system which completes the job of "draining" off the noise and expels them skyward.

Jet engines will be lifted into the test stands by means of an overhead Monorail system and 3-ton hoist. Each stand will be equipped with complete facilities for providing analytical data to the adjacent control room. Here, engineers will be able to look through two large windows, fitted with multiple, separated sheets of bullet-proof glass, and observe jet engine phenomena.

Modern instrumentation, designed by Ryan's engineering department, will assist them in test work. Costing $41,000 this system will measure all forces, pressures, temperatures and speed and flow data pertinent to engineering research. Automatic recording instruments will be used wherever possible to provide permanent data. A multi-element manometer system will provide 60 simultaneous readings which can be photographed for permanent record.

Unlike wind tunnels, or test cells used by ramjets, this turbojet test cell does not require air compressor facilities. The jet engines, themselves, act as powerful air pumps, sucking huge quantities of air into the intake stacks for their own needs.

A test cell is to jet engine development what the wind tunnel is to aerodynamic research. Ryan's original test cell was used to develop the first commercially-built afterburner in the U.S. This afterburner was coupled with the General Electric I-16 jet engine and demonstrated on April 25, 1946. From this new facility, Ryan will gain knowledge which may also exert a profound effect upon the design of the power plants and aircraft of the future.

WESTINGHOUSE

(Continued from Page 21)

performance characteristics, (reportedly 6000 pounds of thrust) went through a 150-hour qualification test, equivalent to more than 75,000 miles of actual flight, or three times around the world at the equator.

The Aviation Gas Turbine Division has become, in comparatively few years, one of the most important of Westinghouse's numerous and varied interests. The company's principal business has been the design and manufacture of implements to generate, transmit, distribute, control and use electric power. But it has ranged into an amazing variety of other fields, including transportation on land, sea and the air; in communications, air handling and conditioning, plastics, metallurgy, and most recently, in the development of the world's first full-scale atomic power plant for the generation of electricity. However, Westinghouse is no newcomer to atomic research. An atom smasher rising above the Research Laboratories near East Pittsburgh, Pa. evidences its entrance into this activity in 1937, at a time when such research was confined to university and government laboratories.

Westinghouse has been interested in improving transportation as far back as 1868, when George Westinghouse, the company's founder, invented the railroad airbrake which helped make the railroads the nation's transportation backbone. On the seas, Westinghouse engineers designed the first geared steam turbine propulsion plant for a vessel, in 1911, revolutionizing the use of power in another medium of transportation.

Today, Westinghouse is vigorously pushing development of the fastest type of transportation, in the air—not only through its jet engine work, but through creation of such auxiliary services as a super-sensitive automatic pilot, three billion candlepower airport approach lights to penetrate the thickest fog, basic electrical systems to meet the needs of modern planes, new metals to permit sustained operation in the stratosphere, meters and electrical controls, radar and other highly-specialized communications equipment.

In its "partnership" with Westinghouse as it helps provide the mighty new J-46 engine extra power, Ryan is sharing with an industrial giant its own specialized skills in high temperature metallurgy. The development of the afterburner is still at the frontiers of aeronautics. Its potentialities, as those of the jet engine itself, are enormous. This is a continuing story with no foreseeable end.

MAINLINER CLINIC

(Continued from Page 11)

Following a plane through overhaul provides a lively demonstration of the dispatch and efficiency of the operation. Drawn by tractor, a big DC-6 pulls up to a hangar. A 25-ton steel door, towering 35 feet high, swings upward at the touch of a button. The tractor snaps into life, pulling the plane into a tailored dock like a tugboat floating a big ship into drydock. As twin steel frameworks drop from the ceiling to enclose the tail assembly, the fuselage is flanked by catwalks suspended from steel girders. Hydraulic jacks hoist the plane off the floor. Within 10 minutes from entry, thirty workers swarm to the attack.

While workers inside the cabin strip away seats, wall lining and carpeting, the engines are disconnected and tires peeled off on the exterior. Train-loads of dollies carry away dismantled units for testing and overhaul. Inspectors clamber over all aluminum skins searching for defects and examine every inch of cabin, wiring, windows and fixtures.

In the engine shop, live steam is used to melt away grease and grime prior to disassembly of each Pratt and Whitney 2400-horsepower Wasp engine. The power plants are completely torn down to the last bolt and pin and strung on overhead conveyors which slosh them through huge tanks of solvents. As they emerge, sparkling clean, each part is numbered to maintain its individual engine heritage.

With the most modern analytical devices, parts are screened and tested. Those judged suitable for continued use are routed to assembly departments. Worn parts are replaced by new components. On the average, each Mainliner engine is completely renewed by the time it has had between five and six overhauls.

Ryan field service representatives maintain close liaison with United's big overhaul base to keep personnel up to date on the latest means for testing, maintaining and replacing exhaust system parts on all Mainliners. The Ryan exhaust systems on Douglas DC-6 airliners have established the outstanding record of service among commercial carriers. Originally designed to provide trouble-free service for at least the period between engine overhauls, these efficient systems have consistently rendered excellent service for extended periods running between 4000 and 5000 hours.

The DC-6 exhaust system is the first ejector type used with commercial aircraft. Pioneered by Ryan, these systems were first used on military Douglas A-20 attack bombers during World War II. By utilizing the velocity of the escaping gases as they are discharged to the atmosphere, the DC-6 exhaust system adds thrust to the airplane's flight. Acting much like miniature jet engines, these "jet stacks" improve airplane performance by 15 to 20 miles per hour.

In converting the design to commercial use, Ryan engineers overcame two obstacles—noise and glare. Using a combination of "siamese" and "triamese" tubes, the objectionable gases are piped to the outboard sides of the engines, away from passenger view and hearing.

The Ryan-built exhausts for the Convair 340 Mainliners are also "jet stack" types providing an extra 255 horsepower at cruising speeds through their added thrust. In addition, they step up engine cooling through jet pump action. The exhaust gases are ejected from the stacks into an augmentor tube, within the engine nacelle. As they escape, they suck large quantities of air from the nacelle, thus pulling more air through the engine compartment. Pioneered by Ryan in the FR-1 Fireball Navy fighter, this aspirating effect keeps "340" engines cool even when idling on the ground.

In the big exhaust systems for the Boeing Stratocruiser Mainliners, another "first" was achieved by Ryan. These systems incorporate the means for powering the first turbosuperchargers used in commercial operations. Widely depended upon in military aircraft during World War II, turbosuperchargers are exhaust gas-driven air pumps which cram compressed air into the engine's cylinders.

Increasing air pressure in the cylinders greatly steps up engine power and provides full rated sea-level power up to alti-

(Continued on Page 26)

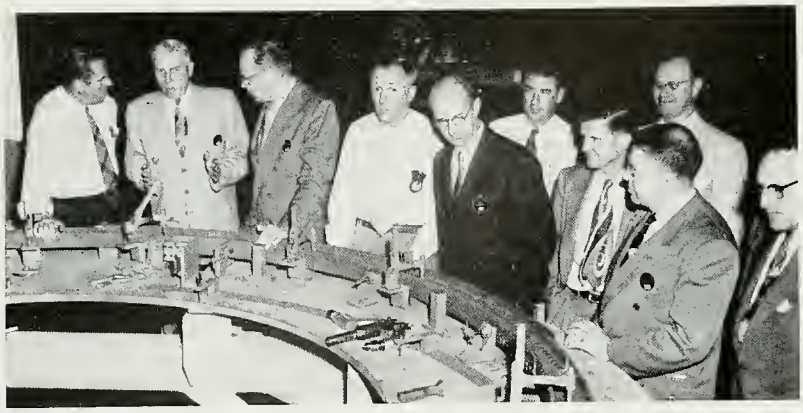
Noted Scientists View Advanced Ryan Projects

Experts from the Office of the Assistant Secretary of Defense for Research and Development visited Ryan March 25, viewed current projects and were given an insight into projected aircraft and missile work planned by the company.

The group was led by Dr. C. C. Furnas, noted scientist and chairman of the Technical Advisory Panel on Aeronautics. Others were Edward Glodeck, Panel secretary; T. C. Muse, acting secretary, Research and Development Coordinating Committee on Piloted Aircraft; Alvin G. Waggoner, assistant to the executive secretary, Coordinating Committee on Guided Missiles; James O. Spriggs, of the Coordinating Committee on Guided Missiles; and Nathaniel C. Fick, of the Technical Advisory Panel on Materials.

Views of Ryan officials were obtained on the adequacy of the turbine engine development program to provide types and sizes of engines needed for the next 10 years. Moving pictures of the Ryan Firebee, jet-propelled pilotless target plane, and a classified project were seen by the visitors, who also inspected the "Model 72" side-by-side Ryan trainer. They were shown Firebees and large power plant assemblies, displayed in the flight service area.

Registering outside a classified area at Ryan are representatives of the Office of the Assistant Secretary of Defense for Research and Development. Left to right, Paul Kemmer, Ryan chief designer; James O. Spriggs, Edward Glodeck, Dr. C. C. Furnas, chairman of the Technical Advisory Panel on Aeronautics; T. C. Muse, Alvin G. Waggoner, and Herman L. Braasch, chief of the aircraft section, Ryan engineering division.



Government, Boeing Officials Inspect Ryan

Government officials and executives of Boeing Airplane Co., Seattle, recently inspected Ryan's production facilities with Larry Limbach, vice president-manufacturing; John van der Linde, factory manager; Jack Zippwald, assistant director of customer service; and E. F. Mellinger, superintendent of manufacturing engineering. Left to right, Limbach, B. Stockfleth, director, application engineering, office of Assistant Secretary of Defense; Boyd Bucy, tool design manager, Boeing; van der Linde; J. H. Garrett, research and development, office of Assistant Secretary of Defense; Zippwald; John Brockway, Boeing Southern California representative; Mellinger; Norman W. Grigg, assistant materiel manager, Boeing; and Robert Welsh, Boeing representative at Ryan.

spelled success for the United Air Lines' overhaul operation is the method of scheduling work on the 22 different aircraft which flow through each month. Key to what would usually be a complex paperwork job, is the Remington Rand Sched-U-Graph system which permits job assignments to be made in a matter of minutes. Each job performed on the airplane during its five-day sojourn is printed on a separate, numbered work card. Twenty-four hours before the aircraft comes into the base, the overhaul planning section assigns job cards to the individual mechanics by name. These cards are then controlled by dock planners located at each of the big overhaul docks. In this way, most of the paperwork for each overhaul is prepared well before the aircraft arrives. Also, the 2700 mechanics and technicians know exactly where they are assigned and a well-defined method for determining the man-hours required for every overhaul has been developed.

Because of its unmatched efficiency in doing the job, United's overhaul base has been visited and extolled by a steady stream of civil and military aviation leaders from both domestic and foreign sources.

MAINLINER CLINIC

(Continued from Page 25)

tudes of 30,000 feet. In addition, turbosupercharging reduces fuel consumption. Both increased power and reduced fuel consumption enable the Stratocruisers to fly at higher altitudes and thus increase their range and payloads. For each 1000 feet increase in altitude, a 1 per cent increase in speed is realized through reduced drag and turbulence.

While engines and exhaust systems are checked, propellers, radios and instruments are overhauled in United's specialized facilities. Radios are adjusted in insulated, air-conditioned booths. Delicate plane instruments are calibrated in decompression chambers and worked on in rooms where dust is controlled by static electricity.

In the propeller shop, the DC-6's four 13-foot Hamilton Standard propellers are dismantled, cleaned and polished. Balancing is done so carefully that the weight of a match stick will put the big blades in motion.

Reassembled engines are sent to modern test cells where they undergo a four-and-a-half hour shakedown "cruise." During this run, heating and refrigeration equipment simulate actual temperature ranges experienced in flight. In an adjoining shop, carburetors are tested under laboratory conditions which duplicate those found in all altitudes up to 50,000 feet.

Finally, all of the DC-6's vital components stream back to the overhaul dock and are expertly fitted to the big plane's waiting structure. Five days have elapsed since the airliner entered the dock and the shining ship is ready to try its wings. It is rolled out and, just to make sure, a special team of inspectors go over every inch to triple check all work accomplished.

Then a flight test crew takes command. They are one of three kept busy at United's base, shaking down 1000 Mainliners a year. Under their experienced hands, the ship is put through all maneuvers—turning, climbing, gliding and stalling. Each engine is switched off and propeller feathered. Both engines are cut on one ship-side to insure that the plane will still cruise smoothly under adverse conditions.

When final flight approval is obtained, the DC-6 Mainliner is "OK'd" and cleared for service between the 83 cities of United's far-flung system.

One of the major factors that has

JET RINGS

(Continued from Page 7)

may be flash-welded into rings and used. Although Ryan uses rings made from all of these processes, between 90 and 95 per cent of the rings procured are of the flash butt welded type.

FORGINGS

Forged rings, or sleeves, possess good structural properties because the metal is refined by the blows of the forging hammer. These rings are produced by flattening a hot, rectangular billet of stainless steel. A hole is then pierced in the center and the disc is laboriously flattened into a large ring, or sleeve.

Because forging is not a precise method of forming, a goodly amount of excess metal is left on the sleeve to cover the final machined dimensions. This metal must be paid for before it is thrown away. Then, extra machining costs must be incurred in order to remove this excess metal to get the finished ring. Forged rings are relatively expensive because their production involves the use of substantial amounts of labor and equipment. Ryan uses forgings when procurement time is limited because they are readily available.

CASTINGS

When cast rings are purchased, excess metal is also a factor which accounts for added weight and extra machining costs.

(Continued on Next Page)

Although castings may run 30 per cent less expensive than forgings, they do not possess as good physical properties because of their grain structure. Also, castings may contain imperfections, such as porosity or occulsions, which render them useless. These defects, not detectable by X-ray, may remain hidden until expensive machining operations uncover them.

With both forged and cast sleeves, Ryan removes more metal by machining than is left in the finished ring. Since these rings are purchased on a weight basis, it is evident that Ryan must discard more than half of the costs of these rings as scrap. Another cost, creeping into this picture, is the added transportation charges required to ship this excess metal to Ryan.

In order to keep these costs down, Ryan obtains forgings and castings in the form of sleeves from which a number of rings may be machined. After machining, each ring is parted from the sleeve by the lathe's cutting tool.

FLASH-WELDED

With the development of modern methods for flash butt welding large stainless steel sections, it is possible to obtain high quality rings at lower costs than forging or casting. American Welding and Manufacturing, Dresser Industries and Taylor Pipe and Forge perform this work. Rolled bar stock in precise thickness, width and length is obtained from steel mills. The following operations are then performed:

(1) The bars are cut to ring length and rolled into circular form. This is accomplished on either a bulldozer or a three-roll machine. Actually, the form obtained is a "D" shape.

(2) The ring is placed in a flash butt welding machine and the ends are welded together. Flash welding is the only type of welding which will perform the joining of such heavy sections to the exacting requirements of jet engine fabrication.

(3) Excess weld metal is removed by chip hammer. The ring is annealed in a furnace and squeezed into circular shape.

(4) The hot ring is placed on an expanding mandrel and sized.

Made from rolled steel, flash-welded rings have good physical properties. They are approximately 45 per cent cheaper than forged rings and 22 per cent less expensive than castings. New flash-welding techniques are providing the means for making the very large rings, running up to 42-inch diameters, which Ryan uses.

MILL SECTIONS

Development of sources for mill sections by Outside Production promises to pay sizeable dividends. Savings, amounting to more than a hundred thousand dollars on recent programs, placed Ryan in an advantageous competitive position with substantial ultimate savings to customers and taxpayers.

Ryan has purchased special rolls for use by the steel mills furnishing bar stock. With these rolls, bar stock having exact cross-section are rolled. The lengths are delivered to the fabricators who flash-weld the stock into rings. The rings are shipped to Ryan.

Now, we have a ring which almost conforms to the exact dimensions required by production. Only finish machining is required. Practically no excess metal has to be removed. Because these rings do not have large sections cut out by machining, they have better physical characteristics. The grain structure of the metal is oriented along the contours of the part.

Frequently, mill sections are rolled with a channel-type cross-section. These are called "siamese" sections because two rings can be machined from each section. The rings are placed in vertical turret or gap lathes and rough-machined. Then, they are parted and finish-machined. This innovation saves machining time and provides a good means for holding one ring while the other is machined.

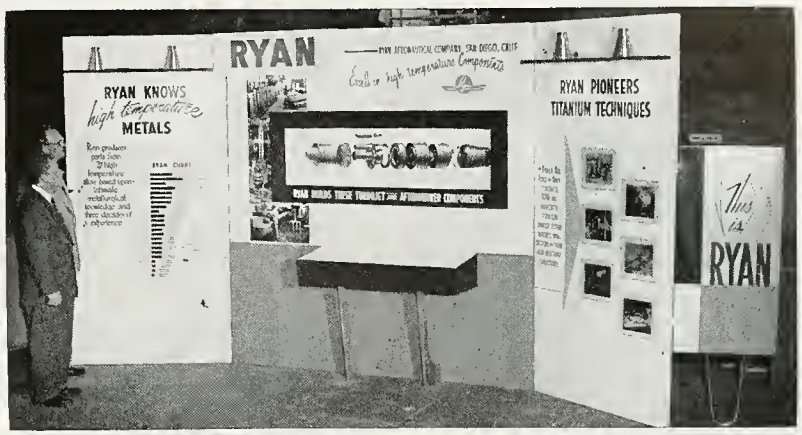
Rings made from mill sections cost only one-half as much as flash-welded rings from rectangular stock and one-fourth as much as forged rings. In addition, they require about half of the machining labor demanded by other rings.

As a result of Outside Production's development of mill sections, standardized methods of procurement, keyed to Ryan standards are being formulated by Production Engineering. Initial planning for new sales orders can then be developed to call for the ordering of rings by either forgings, flash butt-welded rings or mill sections, whichever is most advantageous from a standpoint of schedule and cost.

EXTRUSIONS

Newest trick for making jet engine rings has been divulged by a French method, the Ugine Sejournet process. This is a practical method for producing solid and hollow sections of high alloy steels through extrusion. The hot billet is impregnated with glass wool and pushed through a die. The fused glass film acts as a lubricant, preventing metal-to-metal contact between billet and die.

Extrusion takes between two and four seconds to produce sections running up to 40 feet long. Because of the low cost of the dies, compared with steel mill rolls, and the ease with which they can be put to use, this new process promises jet rings at lower costs. However, other factors, such as die life, must be taken into consideration to determine if a particular run can be produced more economically by this method. The process is capable of producing hollow sections which cannot be made by hot-rolling methods.



Ryan Exhibit At National S.A.E. Meeting

This exhibit by Ryan occupied one of the largest booths in the grand ballroom of the Hotel Statler, New York City, April 12-15, at the annual national aeronautic meeting of the Society of Automotive Engineers. The display depicts Ryan's leadership in a diversity of products in the high temperature field. Stressed is Ryan's research and production leadership in working with 27 high temperature alloys which are the basis of jet engine metallurgy. Some of the nation's leading engineers and aviation executives viewed this exhibit, which will be shown later at other shows throughout the country.

FROM FIREBEES TO SEABEES

(Continued from Page 9)

tory's determination of the proper proportion of resin and catalysts for the foamed-in-place plastic and selection of proper sealants for compartment sealing, an Air Force Q-2 version of the Firebee was modified for the test program. Preparations included marking major design waterlines and station lines on the target and installing a manually-operated time indicator on the vertical stabilizer.

In the first of a series of three tests, the target plane—complete with J-44 turbojet engine installed—was ballasted at the 50 per cent fuel load condition. A sling was attached to the plane so that it hung in the usual 10-degree tail down attitude assumed during normal parachute recovery; then it was unceremoniously dropped into the sea from a height of six feet. Dropping from this height produced a 20-foot-per-second impact—the same that occurs in a normal parachute landing.

Entry speed into the water was reduced considerably by the wings and horizontal stabilizer so that the target assumed a stable floating position almost immediately. In the 60 minutes it was in the water, the target settled slightly by the nose from a two-degree to a 5-degree nose down attitude. Following removal from the water, the target was rinsed thoroughly with fresh water under moderate pressure to remove all salt water and salt deposits in order to prevent corrosive action.

Subsequent tests were conducted with the Firebee ballasted at the 25 per cent, then the 90 per cent fuel load condition. Following completion of the latter test, the target was returned to the Ryan plant where it was allowed to stand 24 hours before being rinsed thoroughly with fresh water. For the next 30 days the target was inspected daily to determine what parts were affected by the salt water baptism.

At the conclusion of the test program, the test results obtained indicated that the flotation provisions afforded the Firebee were more than adequate to meet the required one hour's flotation for half fuel load conditions. A study of the corrosive effect of the salt water revealed which areas of the target were most susceptible, and what should be done to eliminate corrosion in those areas.

Armed with this information, Ryan modified and delivered five Air Force Q-2's with flotation provisions to the NAMTC for use in the flight test program at Pt. Mugu. These provisions will, of course, be standard in the KDA-1's now under production and scheduled for delivery to the Navy in the summer.

Not unlike the Holloman Air Development Center in New Mexico where Ryan and the U. S. Air Force are conducting a research and development program on the Firebee, the Naval Air Missile Test Center is dealing with the electronic push-button potentialities of the future.

The NAMTC was established in 1948 by the Navy's Bureau of Aeronautics to serve as an over-water guided missile test range for missiles designed to travel both short and long distances. It complements the Air Force Missile Test Center at Cocoa, Florida, and the Army's White Sands Proving Ground in New Mexico.

The mission of NAMTC, which is commanded by Captain E. M. Condra, is the "test and evaluation of guided missiles and their components." While most of the work being done is necessarily cloaked in military secrecy, it is generally known that the Navy has reached the advanced stages in the development of such missiles as the Regulus and the Sparrow at this huge base.

Ryan activities at Pt. Mugu are centered in what was once the NAMTC's operations hangar. This structure was made available to the Ryan group by the Navy and serves as the present Ryan office, shop and overall base of operations. Here the targets are assembled, checked and double-checked prior to flight.

The Firebee flight test program at NAMTC is currently in what is known as a "Phase A" Program. This consists of a joint Navy-Ryan evaluation of the target plane's remote control equipment, performance characteristics, flotation capabilities, etc. It is during this particular phase that the contractor demonstrates compliance with the requirements specified by the Navy.

Responsibility for the flight test evaluation of the Firebee rests with NAMTC's Missile Division III, commanded by Cdr. R. M. Hayler. The Firebee project officer is Lt. George Miller.

Missile Division III utilizes a wing launch system to get the "bird" into the air. The target plane is cradled in the wing rack of a JD-1 launch plane, the Navy version of the Douglas twin-engined B-26, and dropped by means of the electric bomb salvo switch. A water-filled ballast tank is mounted on the wing opposite that carrying the Firebee to provide balance.

While the majority of the evaluation flights will end with a very wet "bird," it is planned to "command" recovery of the Firebee over San Nicolas Island on occasion. Located approximately 60 miles off Pt. Mugu, this tiny—three by nine miles—island serves as a missile tracking station in support of NAMTC's sea test range. A force of 200 sailors and civilians man the radar equipment and optical and photographic tracking devices used in the missile experiments.

On completion of NAMTC's Phase A program, the Ryan target plane will enter what is known as the "user's" evaluation —"Phase B." During the latter phase the Firebee will be tested for suitability while in actual operation in support of the fleet.

With the initiation of the NAMTC program, the high-speed jet target planes are now streaking through the air over both land and sea. The Firebee research, development and test program conducted during the past two years at Holloman Air Development Center, Alamogordo, New Mexico, continues under technical cognizance of the Air Force's Air Research and Development Command.

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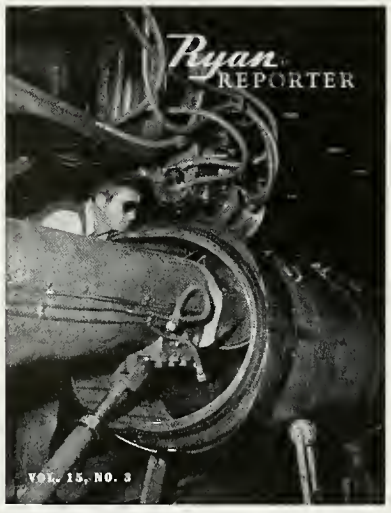

A yawning jet nozzle is "stitched" to a General Electric afterburner with a huge seamwelding machine in the Ryan plant. Robert Ogier supervises the welder which can exert 11,000 lbs. of force and "fire" 120,000 amperes. Lower electrode arm is 60 in. long and located 62 in. above floor.

VEAL OR MILK

"A CALF IS BORN. The farmer can enjoy it as roast veal. Or— he can deny himself that enjoyment, raise the calf to a cow, and then sell her milk. It's a good thing for you and your children that so many farmers denied themselves the veal and saved the calf for cow's milk.

"THIS IS EXACTLY WHAT HAPPENS IN INDUSTRY. Thousands of people, with a little money each, can spend that money on themselves. Or, they can deny themselves, save the money, and invest it in machinery. It's a good thing for you and your children that so many people have denied themselves and saved enough to pay for today's machinery—without which modern high-wage jobs would never be possible.

"NO ONE WOULD DENY that the farmer has helped everyone and has a right to the earnings from his cow. No one can deny that the saver has benefited workmen and has a right to the earnings on his savings.

"THAT'S ALL THERE IS to CAPITAL and DIVIDENDS."

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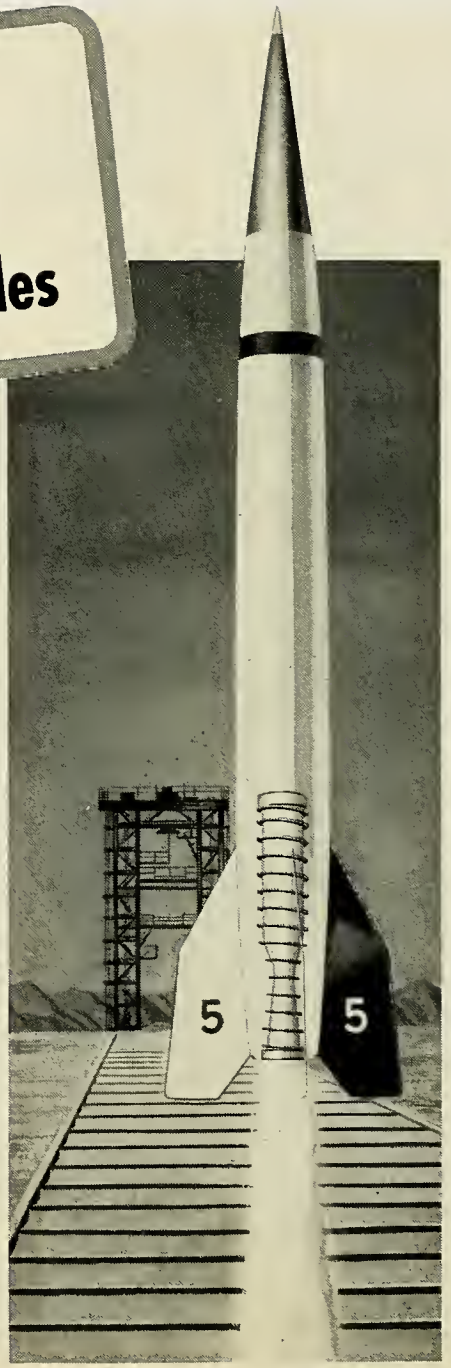
RYAN builds ROCKET MOTORS for 3000 mile-per-hour missiles



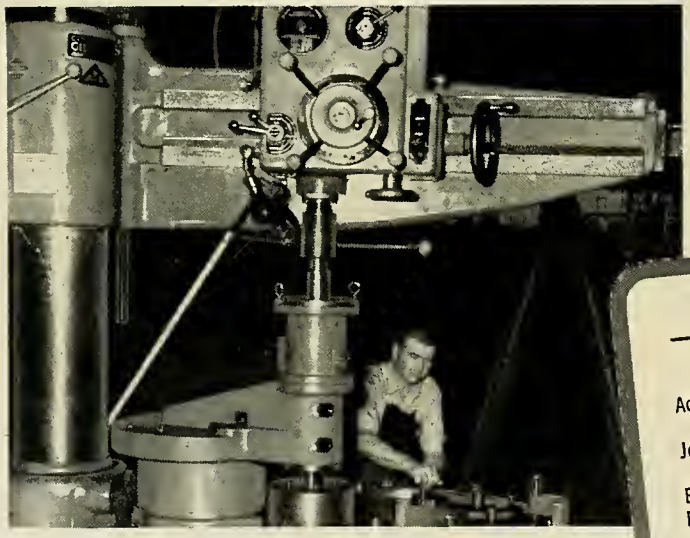
IMAGINE a motor powerful enough to propel a missile at speeds exceeding 3000 mph . . . so powerful that its developed thrust can amount to tens of thousands of pounds. One of Ryan's most challenging current assignments is the complete production of such a motor for an Army Ordnance surface-to-surface missile.

There was a many-sided problem of fabrication, welding and machining that Ryan had to solve in connection with rocket motor manufacture. Because a rocket motor is capable of burning as much as a ton of fuel a minute at temperatures up to 5000 degrees F., terrific internal pressures are created that must be contained in a very compact package of complex construction and exacting dimensions.

The solution was found in perfecting new techniques for forming, welding and machining the special alloy materials. Ryan devised new methods of controlling work to very close tolerances; ingenious electric resistance and arc welding processes and a better furnace brazing system . . . plus intricate machine operations that had to be jewel-like in precision.

Ryan's proved ability in the production of complete rocket motors is due in large measure to its long experience in building the "hot end" of jet and piston engines. Its versatility in many specialized fields is an important advantage in each new assignment, for it enables every division to draw on 31 years of first hand experience in the most advanced phases of aviation engineering and production.

Thus, each year more unique technical engineering and production projects are awarded Ryan . . . an integrated company with superior abilities in meeting the challenges of today's high-speed air age.



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Firebee Pilotless Jet Planes

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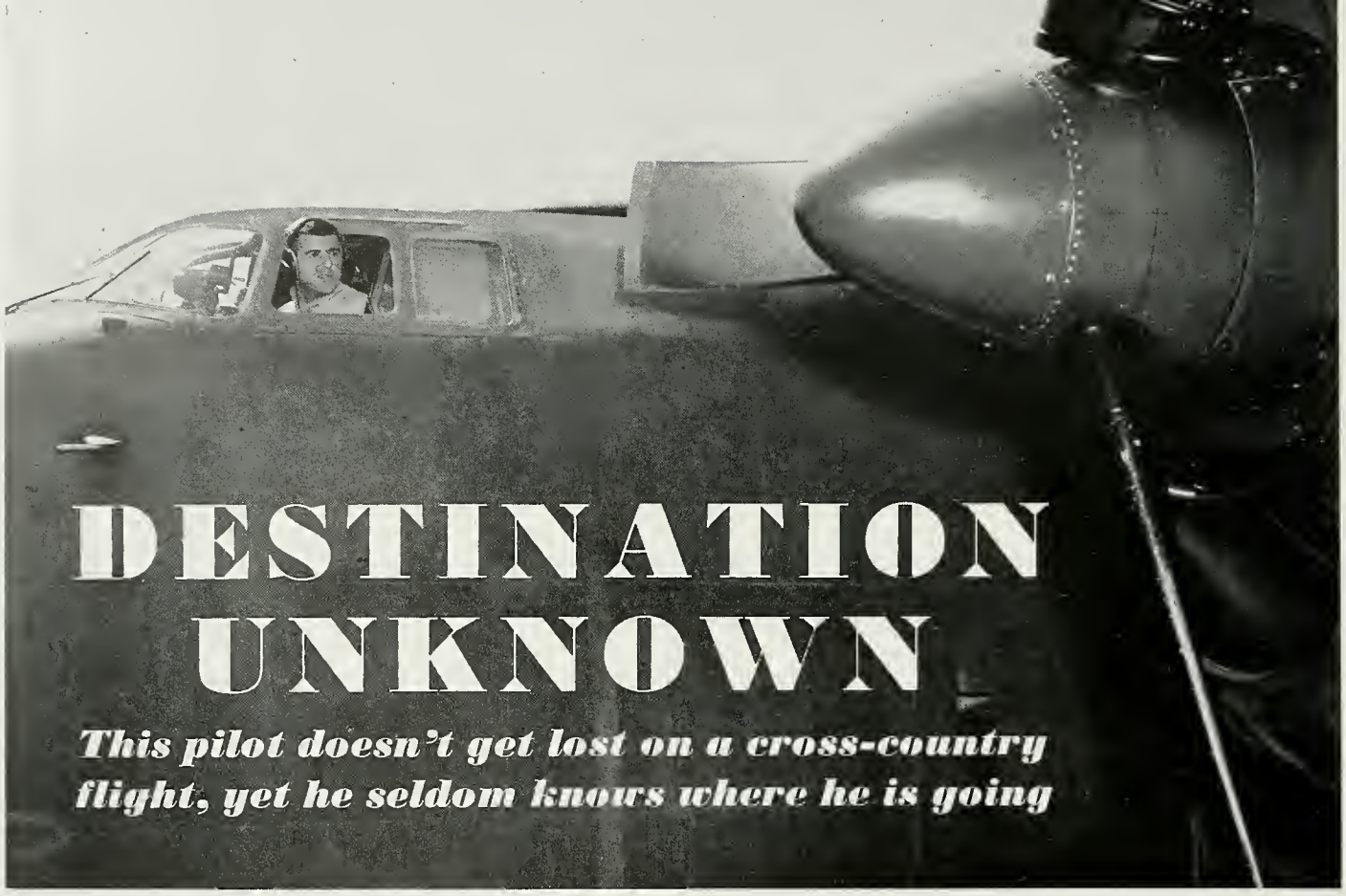


DESTINATION UNKNOWN

This pilot doesn't get lost on a cross-country flight, yet he seldom knows where he is going

IN A MOMENT it will be time to start engines. The uniformed Ryan plant guard strides over to the long gate leading from the aircraft parking ramp to one of the taxiways of Lindbergh Field.

As the gate slides open, the small huddle of men, talking quietly in the shade of the big P2V Neptune's wing, drifts apart. Three walk to the midsection of the plane, duck under the belly and disappear, one by one, up through the hatch. The other three—pilot, copilot and crew chief—stroll around the plane in a brief but searching preflight inspection, then clamber aboard through the foreward hatch.

Moments later, the engines, one followed by the other, cough, sputter and roar to life. The hatches close, the flaps come up and the bomb bay doors silently come together.

Inside, the pilot picks up his VHF "mike." "Lindbergh Tower, this is Navy 950 . . . over."

"Go ahead, 950, this is Lindbergh Tower," crackles the voice in his receiver. "Lindbergh Tower, Navy 950 requests taxi and take-off instructions," answers the pilot.

"Roger, 950, you are cleared to taxi across the active runway into runup position on runway 27."

In runup position, the pilot turns the plane into the wind, locks the brakes and methodically checks his flight instruments, engine instruments and controls as the copilot reads off the items from the check list.

"Lindbergh Tower, Navy 950 ready for take off."

"Roger, Navy 950, clear to take the active runway."

The pilot taxis the plane out onto the runway, lines it up with the runway heading and takes a quick last look at his instruments before adding power. With the throttles open, the two engines roar as the P2V gradually picks up speed. In a moment, the twenty-ton aircraft is airborne.

Up to this point, the routine has been completely normal. Thousands of aircraft operating from hundreds of military and commercial fields throughout the nation follow the same general procedures daily.

Ryan engineering pilots, Al Coha, left, and Dick Yoder, right, prepare to take off on their unusual mission. Instrument that will guide Coha to his unknown destination is shown at the extreme top center of photo.

But there is one marked incongruity between this particular flight and many of the others. . . . *The Ryan pilot does not know his destination.*

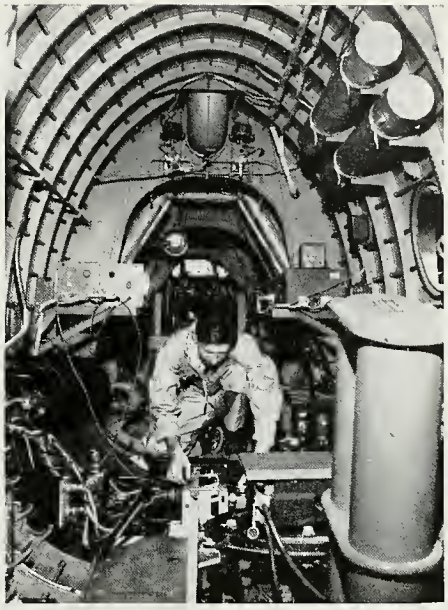
Keeping pilot A. P. "Al" Coha "in the dark" insofar as his destination is concerned is the Electronics Section's somewhat unorthodox, but highly effective, method of obtaining comprehensive data on the reliability and accuracy of a new Ryan electronic navigational system.

Coha's duties as the plane's navigator cease as soon as the aircraft arrives over a predetermined landmark at a predetermined altitude. At that point, the Ryan navigational device takes over. To reach his unknown goal, Coha need only fly an aircraft heading which will maintain the course error indication on his cockpit instrument panel at zero.

The navigational device and the three electronics engineers riding along to monitor and record its performance will inform Coha of his arrival at the unknown destination when he gets there.

In that Pilot Coha does not know where he is going, he is not hindered by the normal tendency to "assist" the device by flying "pilotage" or "contact" navigation. The result is an extremely accurate check of the navigational device's performance under actual flight conditions.

This is one of a continuing series of tests conducted during the advanced evaluation of Ryan's airborne navigational equipment in its only "true" environment . . . the air. For this purpose, the Lockheed P2V Neptune was loaned to the company by the U. S. Navy. It serves as a "flying laboratory," enabling Ryan engineers to maintain a close check on electronic equipment performance under actual in-flight operating conditions.



During the flight, Paul Munchus monitors the navigational and recording equipment installed in the aft section of the P2V.

Ryan is well qualified for this type of work because of its extensive experience in, and facilities for, the production, operation and maintenance of aircraft. In-flight testing of experimental equipment is expedited by operating a fleet of aircraft, one of which is the P2V, from the runways of Lindbergh Field, immediately adjacent to the Ryan plant.

The electronics engineers who man these "flying labs" seek not only to establish the adequacy of final equipment, but also to develop new techniques which will eventually be embodied in more advanced designs.

Aboard the P2V, the engineer in charge of the three-man flight test team from the Electronics Section is E. Bruce Clapp. He spends the majority of his time during the flight in the navigator's compartment. From this vantage point, he can observe and quickly analyze the data presented in visual form on the Ryan navigational computer-indicator.

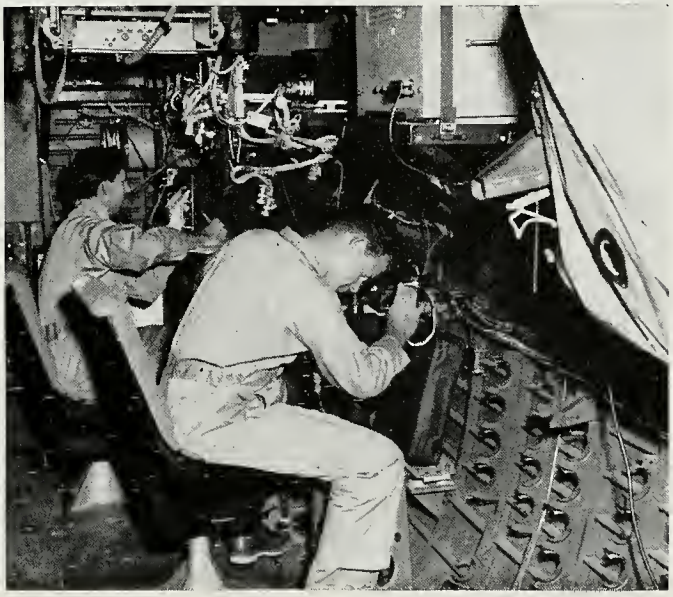
Clapp, of course, knows the P2V's destination—he's the one who "sets up" the navigational device with the information it requires to instruct Al Coha along the course line via the pilot's direction indicator on the instrument panel. As a matter of fact, everyone aboard the plane knows its destination with the exception of Al Coha.

Copilot Dick Yoder, seated to the right of Coha, has a map on his lap and is keeping a critical eye on the navigation. Prior to the flight, he checked the weather, filed the flight plan and studied the route for the landing strips that might be available in the event of an emergency.

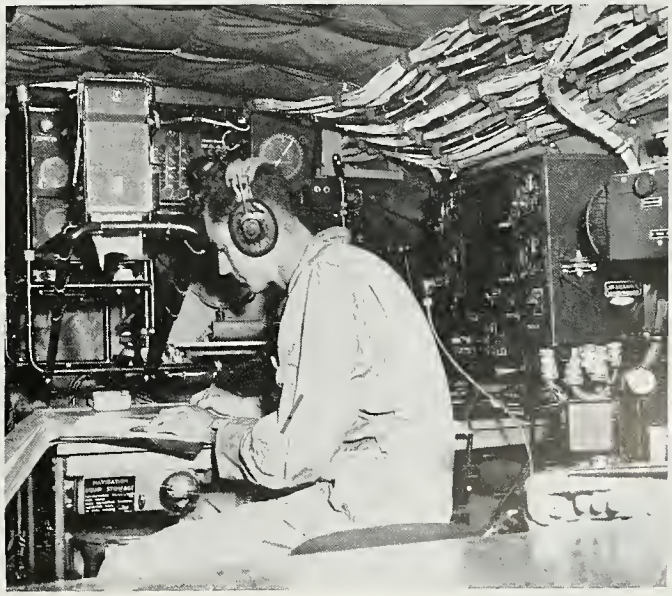
As the plane drones steadily on its course, Bruce Clapp is busy with compass, ruler, pocket computer and aeronautical charts, checking his own navigation with that of the Ryan device. Occasionally, he speaks to one of the other crew members somewhere in the plane through the "intercom," or rises to substitute a fresh roll of film for the used one in the Polar-

(Continued on Page 27)

Warren Norris, his hand poised over the button that triggers timing devices aboard the aircraft, squints through the drift sight at ground below as Paul Munchus monitors the equipment.

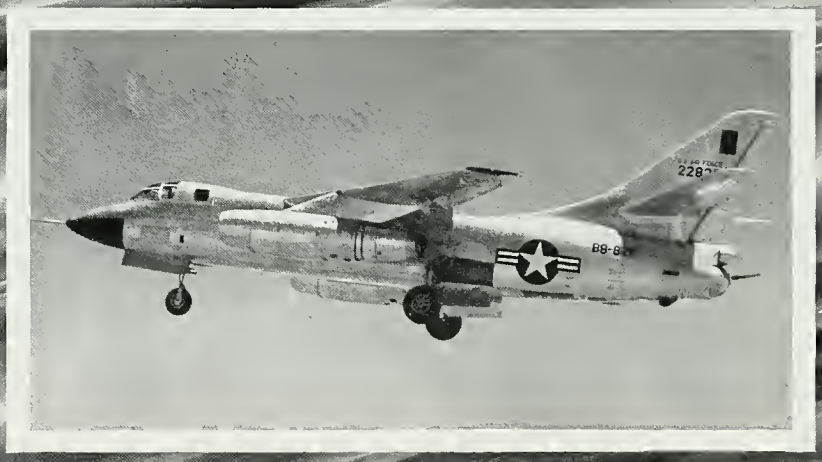


Sitting at the navigator's table aboard the P2V "flying lab," Bruce Clapp is busy with chart and ruler as he checks his own navigation with that of the navigational device being tested.



THIN WALL DUC

Ryan delivers heat and power through air filled tub



TING

steel

RYAN is building hot air arteries for jet planes. Made from thin wall ducting, these gleaming tubes of stainless steel pipe heat and power from jet engines to perform vital plane tasks. With them, engineers are tapping a new source of airborne power which promises welcome advantages in light weight, efficiency and simplicity.

Flying at high speeds and altitudes, modern aircraft live in a world of their own. It's a strange world where temperature sinks to −67° F., atmospheric pressure plummets to less than two pounds per square inch and human blood boils at body temperatures. Under these severe conditions, pilots, passengers, power plants and equipment must function in an artificial environment.

Newest Air Force reconnaissance bomber is the Douglas RB-66 which is fitted with thin wall ducting components of special Ryan design

To provide this environment, a variety of ingenious devices compress, cool, heat, humidify and circulate air throughout the aircraft. Superchargers collect thin outside air, compress it and cram it into pilot's and passenger's compartments to maintain livable pressures and sufficient oxygen for breathing. Compressed air is also packed into piston engines to sustain their power.

Because pressurizing raises air temperature as much as 160° F. above initial levels, the air must be cooled. This is done with amazingly efficient refrigerating turbines which spin at 100,000 r.p.m. to cool the air by expansion.

Under certain conditions, heat must be added to the aircraft's air supply to keep pilot and passengers comfortable, prevent icing of wings, control surfaces and carburetors and maintain functioning of electronic, armament and hydraulic equipment. These air conditioning devices require power for their operation.

In addition to the environment needs, there are countless other tasks to be performed in a modern airplane which require the application of power. Starting engines, operating landing gear and brakes, actuating flaps and control surfaces and opening bomb bay doors are just a few of the major requirements.

As a result, modern aircraft are pretty will stocked with small electric motors, hydraulic actuating devices, auxiliary engines, gas turbines and other types of power sources.

In aircraft equipped with reciprocating engines, mechanical drives are used to divert the energy necessary to power electrical and hydraulic systems. In jet-powered aircraft, it is difficult to use mechanical drives to tap power because of the extremely high r.p.m. of the jet engine's rotating components. Fortunately, there is no need to utilize this system because the jet engine is admirably suited to meet auxiliary power demands in another way.

The turbojet power plant consumes tremendous masses of air, running as high as three to four tons per minute. As it enters the engine, this air is compressed in two ways; by virtue of the ram effect produced by the aircraft's high velocity and by means of the efficient action of the whirling compressor blades. Pressures from 50 to 250 p. s. i. are achieved. These phenomena produce a decided temperature rise boosting the air to temperatures of between 500 and 900° F., depending upon engine design and operating conditions. Velocities are accelerated and can soar to the sea-level speed of sound—764 miles per hour.

Consequently, turbojet engines are a source of high pressure, high temperature air which is moving at swift velocities. This energy-laden gas stream is made to order for meeting the air conditioning and power needs of aircraft. For pressurizing and heating, air bled from the compressor section is the end commodity and little equipment is required to bring it into effectual use.

For powering electrical, hydraulic and refrigerating systems, compressor-bled air can be efficiently employed throughout the aircraft. This provides multiple advantages. Motors and hydraulic actuating devices may be located at points of application and weighty electrical cables and hydraulic lines reduced to minimum runs by powering these units with light-weight, air-filled tubes. Safety features accrue by lining the airframe with air-filled ducts rather than hydraulic fluids which can burst into flames within the structure in case of combat or accident damage.

Use of compressor-bled air provides fewer sources of power with greater dependability. If different types of power are required, such as different voltage electrical power, the system lends itself to these varied needs while electrical energy taken from a main engine drive does not have such flexibility. Another salient advantage is that the aircraft engines are kept aerodynamically clean because auxiliary components are removed from the front of the engines and placed inside the aircraft structure. This enhances engine streamlining and provides welcome savings in time and money at engine replacement time. Power plants can be quickly removed from their nacelles without bothering with a host of engine accessories.

From one to three per cent of the volume of air compressed by the turbojet's compressor is usually required to meet an aircraft's needs. Naturally, taking this amount of air from a jet engine's power section would reduce the maximum thrust which it is capable of developing. However, this is not a material factor because of two reasons. The air is drawn upon for power use—to operate landing gear, brakes, flaps, bomb bay doors and so on—for intermittent periods of short duration and at times when the engines are not called upon to deliver maximum thrust. Under these conditions the engines have a goodly reserve of air and the drain is not felt.

Also, in order to efficiently feed an aircraft ducting system, the turbojets should be designed with these requirements in mind and with provisions for the production of extra quantities of compressed air. This means, of course, that engine designers must know well in advance what the requirements of new aircraft will be because both new engines and airplanes are designed several years ahead of their eventual production. Also, it imposes greater responsibility upon engine designers to match power plants with specific aircraft because the additional power requirements are indigenous to the airframe design.

A major benefit derived from use of bleed air from turbojet compressors is

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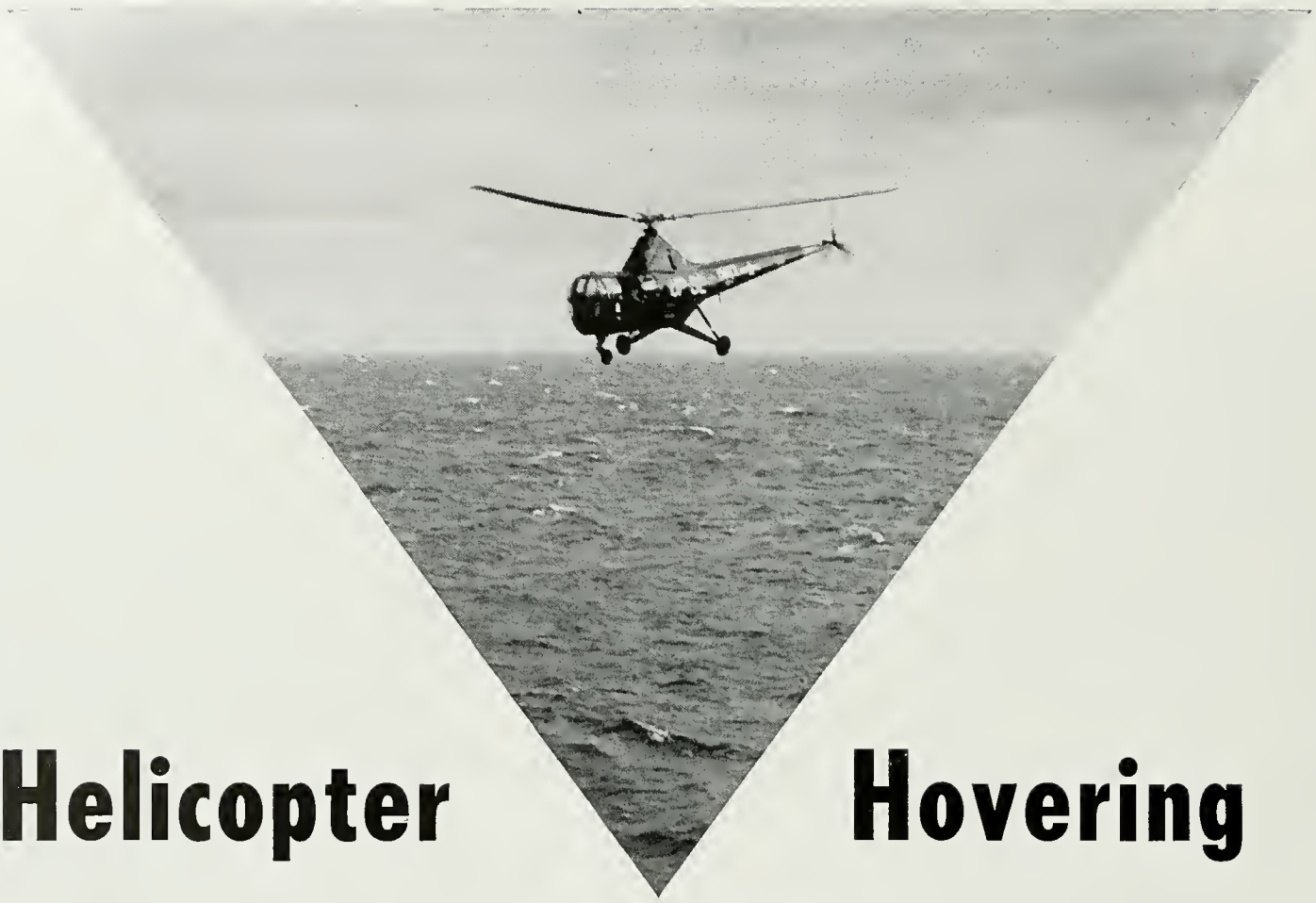


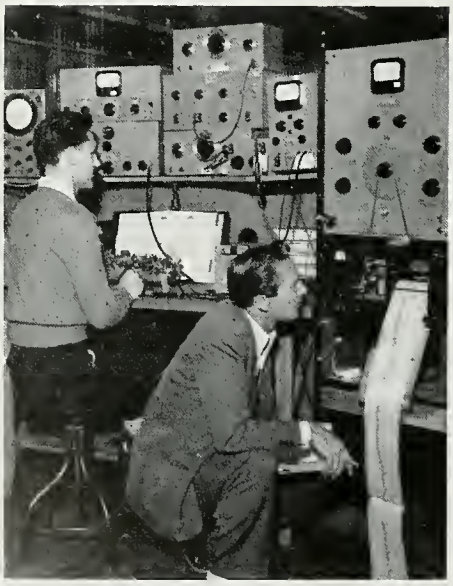
Helicopter Hovering

Ryan receives Navy contract to develop new electronic device for helicopter use

A CONTRACT for the development of a self-contained airborne helicopter hovering device has been awarded the Ryan Aeronautical Company by the Airborne Equipment Division of the U. S. Navy Bureau of Aeronautics, company officials announced recently. The work will be done by Ryan's expanding Electronics Section.

The hovering device is an outgrowth of Ryan accomplishments in the field of airborne navigation equipment. Following initial research by the company on the new hovering device, the Bureau of Aeronautics awarded a contract for more advanced development in this field.

Extremely versatile, Ryan's electronic navigational devices, being developed under Navy contracts, provide not only a means of performing navigation and helicopter hovering, but also aid in the accomplishment of other special tasks such as bombing and photography.



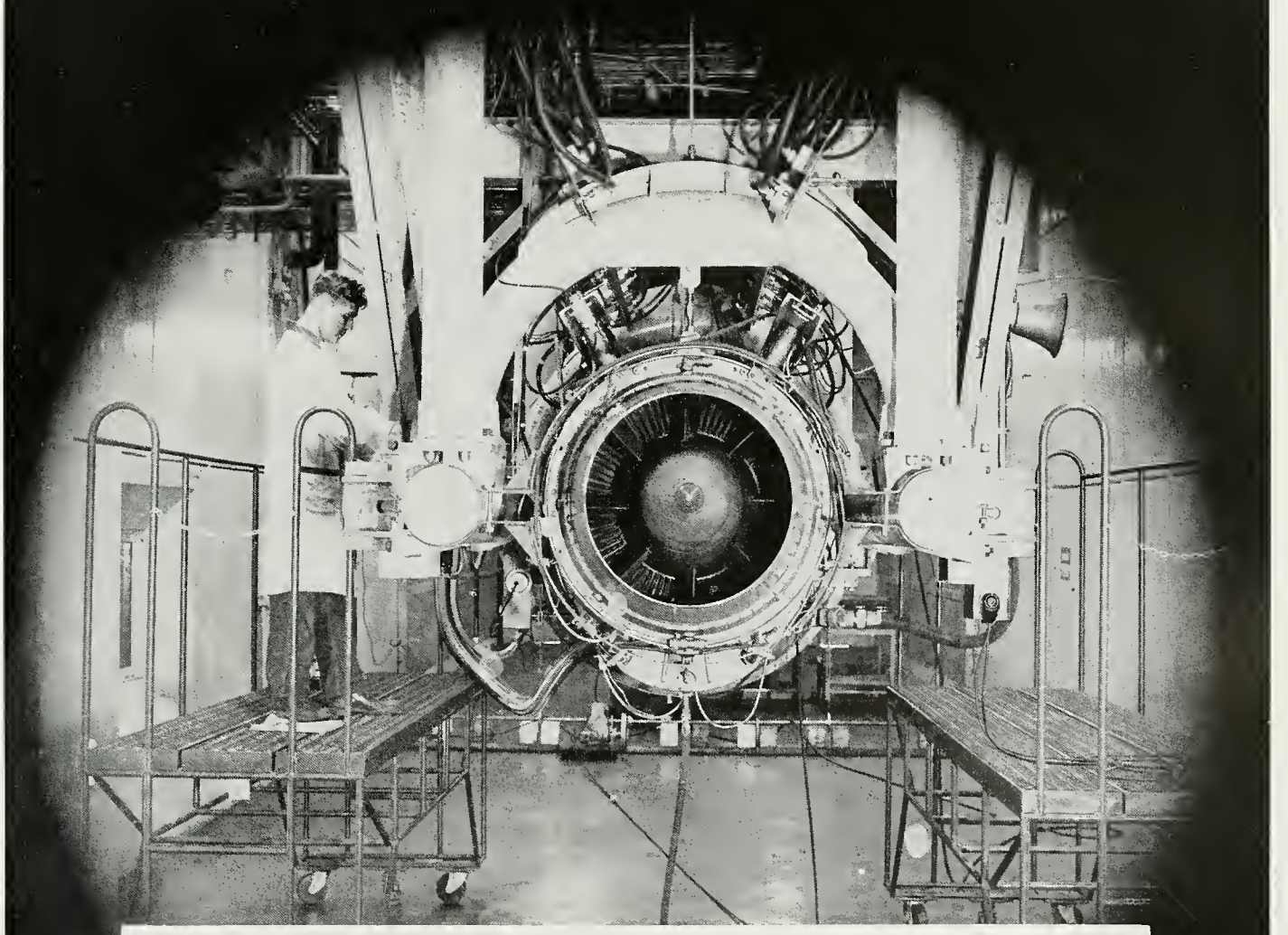
D. E. Trumbo and N. A. Seely, electronics engineers, measure frequency response of complex electronic circuitry used in new navigational equipment developed by Ryan.

In addition to this development work, Ryan is currently manufacturing limited quantities of airborne navigational systems. The manufactured items are now being utilized by the Navy in the accomplishment of a highly important task that has not yet been publicly disclosed.

Ryan is also working on advanced electronic guidance systems for the U. S. Air Force and continues to produce the complex electronic equipment for the Ryan Firebee pilotless jet target plane.

FORD BUILDS J-57s

A world leader in the mass production of automobiles enters the jet engine field with a sure winner

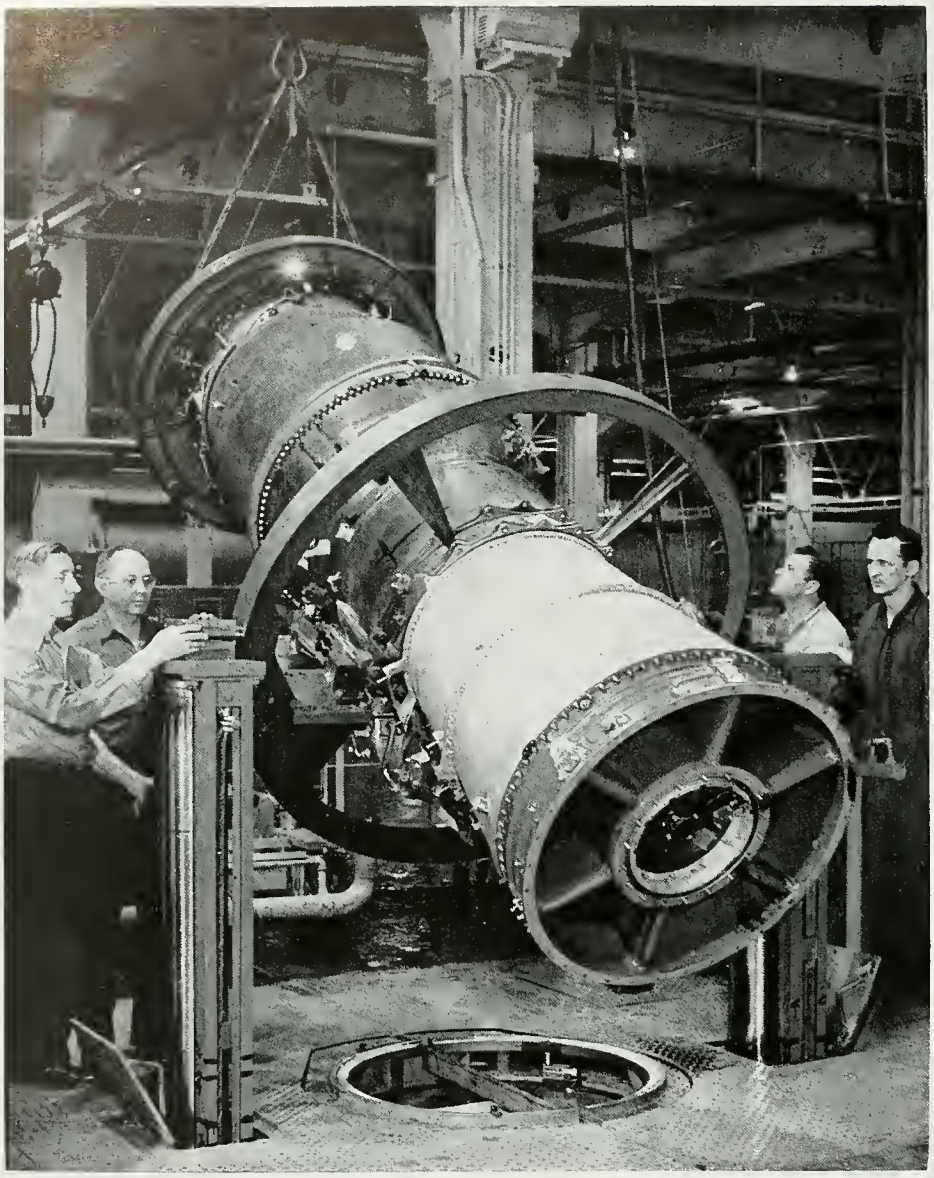


IN THE world's largest industrial plant, the Ford Motor Company is building the most powerful aircraft engine known to be in production. This is the J-57 turbojet which Ford's Aircraft Engine Division produces under license from Pratt and Whitney Aircraft—the designer.

With 16,000 employees and 6,600,000 square feet of floor space, Ford is turning out the J-57 in the Chicago facilities in which the company recently completed 2000 Pratt and Whitney Aircraft Wasp Major engines.

Ryan fabricates a wide variety of the precision-made structures which both Ford and Pratt and Whitney Aircraft use in producing the J-57 and its afterburner. These include compressor

(Continued on Next Page)

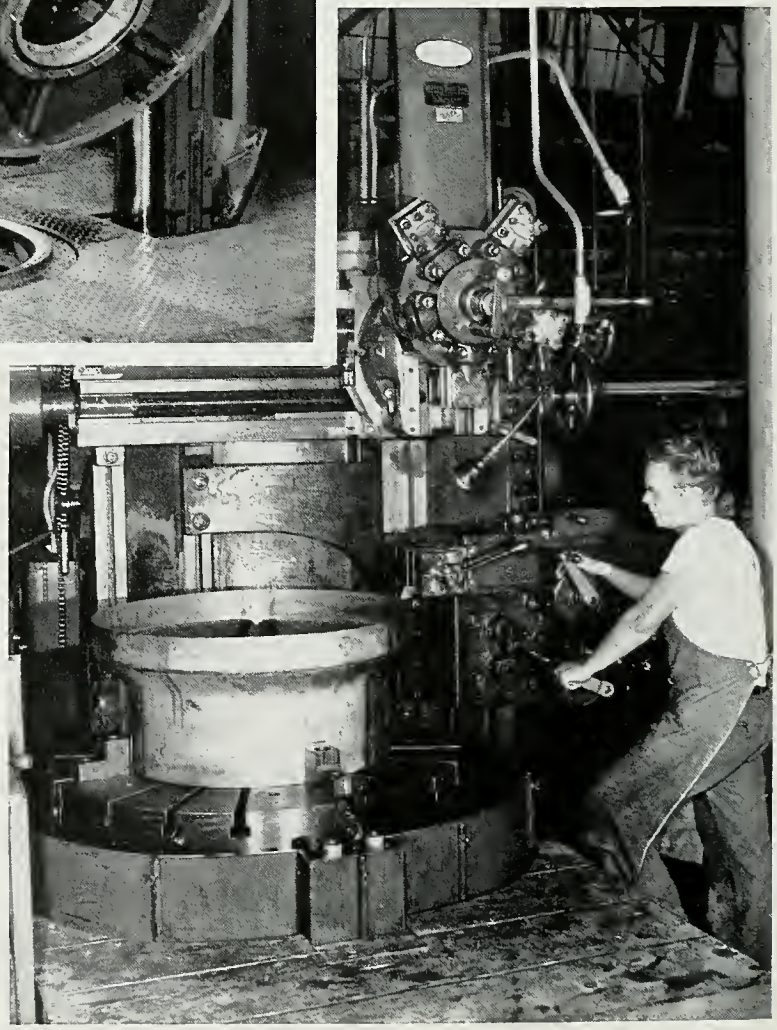


Ford-built J-57 comes out of construction well to be placed in cradle and taken to test cell. Ford assembles these engines in vertical manner with elevator-type supports which sink into the floor, providing full access to each assembly.

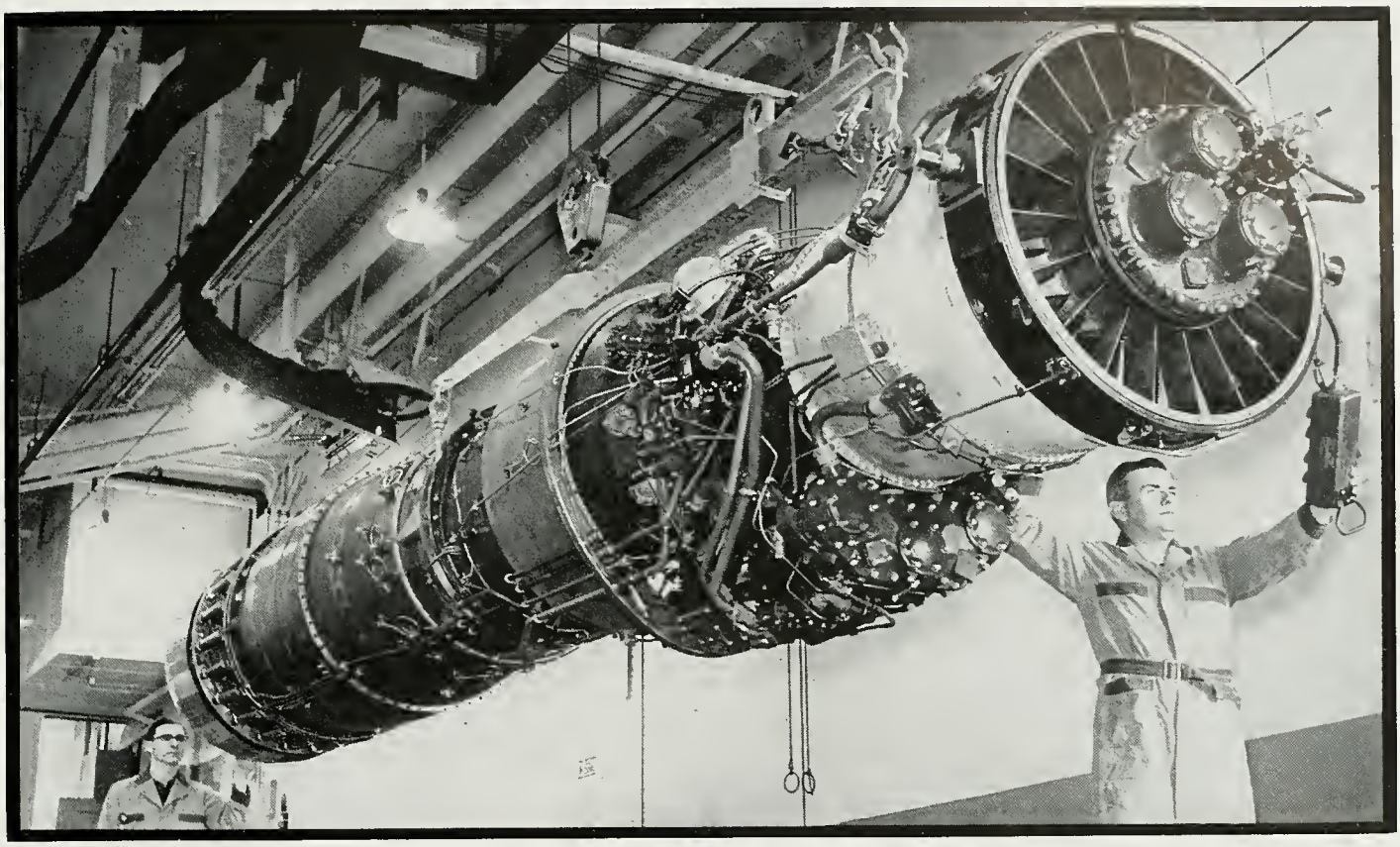
and turbine cases, flameholder and combustion chamber weldments, afterburner ducts, engine mounting cases and many other high temperature components. Three years ago, Ryan began building experimental parts for the big engine and has expanded this work into a flow of production volume.

Rated in the 10,000-pounds-of-thrust class, the J-57 is reported capable of delivering 14,500 pounds with an afterburner. The afterburner version powers the Convair F-102 delta wing interceptor, North American F-100 Super Sabre, Douglas F4D Skyray and McDonnell F-101 "Voodoo." Other J-57 versions are fitted to the sleek pods of Boeing's big B-52 bomber and new 707 Stratoliner and Douglas' A3D attack plane.

Because of its advanced design and the successful way in which it has met its predicted performance, the J-57 is scheduled to be the major Air Force engine for the next three years. Ford is well equipped by both experience and facilities



Ryan machines a stainless steel J-57 weldment on a Bullard vertical turret lathe. The J-57 design incorporates large formed, welded and machined structures which are a Ryan specialty. High precision is key factor in the fabrication.



Pratt and Whitney Aircraft displays the J-57 with afterburner which thrusts the F-100 Super Sabre faster than the sonic speed.

to assume the number two position as a J-57 builder—second only to Pratt and Whitney Aircraft.

During World War II Ford achieved industry acclaim by building 8,685 four-engined B-24 Liberator bombers and over 57,000 2000-horsepower aircraft engines of Pratt and Whitney Aircraft design. In October, 1950, Ford returned to the aircraft engine business, at the request of the government, to produce the 28-cylinder Wasp Major engine.

The company took possession of the world's largest industrial plant—a huge $75 million facility—which the government built in Chicago in 1942. At the war's end, this plant was used as a mammoth storage depot. When the Ford AED crews arrived, there were 20 million items in storage. Within four months, the plant was cleared for installation of 3,200 production machines. Each machine tool had to be stripped, inspected, repaired and greased. Motors and controls were rehabilitated and the machines test run before final approval.

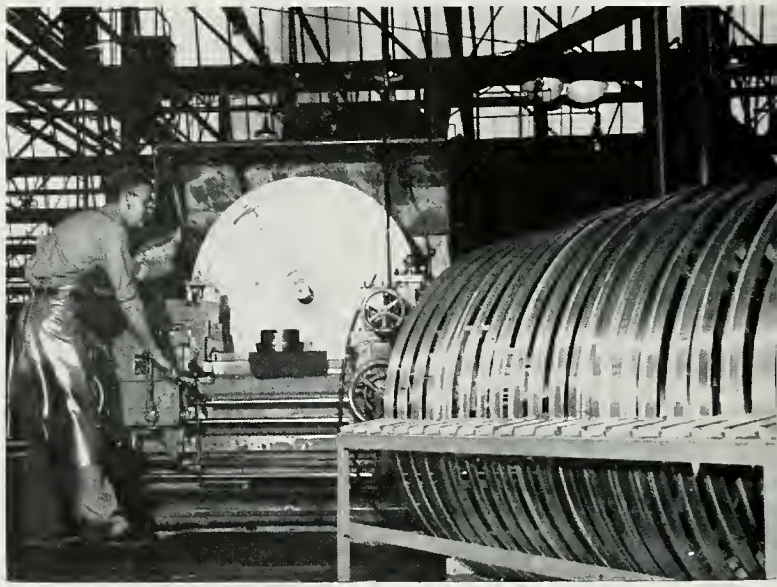
The plant's tremendous production areas had to be renovated with plumbing, wiring and heating facilities brought up to date. Offices were equipped, cafeterias reopened and engine test cells modified to handle larger power plants. Within 18 months after taking possession, Ford had accomplished all of these tasks and had tooled up to produce the Wasp Major engine.

The first Ford version of this 3500-horsepower engine rolled out the door

(Continued on Page 26)

Ford Vice-President John Dykstra and Asst. Gen. Mgr. V. Z. Brink (2nd and 4th from right) inspect J-57 afterburners in Ryan plant with Ryan Vice-Pres. L. M. Limbach and Asst. Factory Mgr. R. Clark.

Glistening Ryan fuel tanks, in foreground, are strong, light-weight structures achieved through specialized spotwelded design.



Large aluminum alloy rings are machined to precision by Ira Aldridge on new Lodge and Shipley T-lathe. These rings are used to bolt tank sections together at break-a-way joints.

Tank splice rings are arc welded with inert gas shielded method by Ernest White. These light-weight rings are used to back up the butt welded tank joints which are joined with spotwelding.

RYAN TANKS FOR BOEING TANKERS

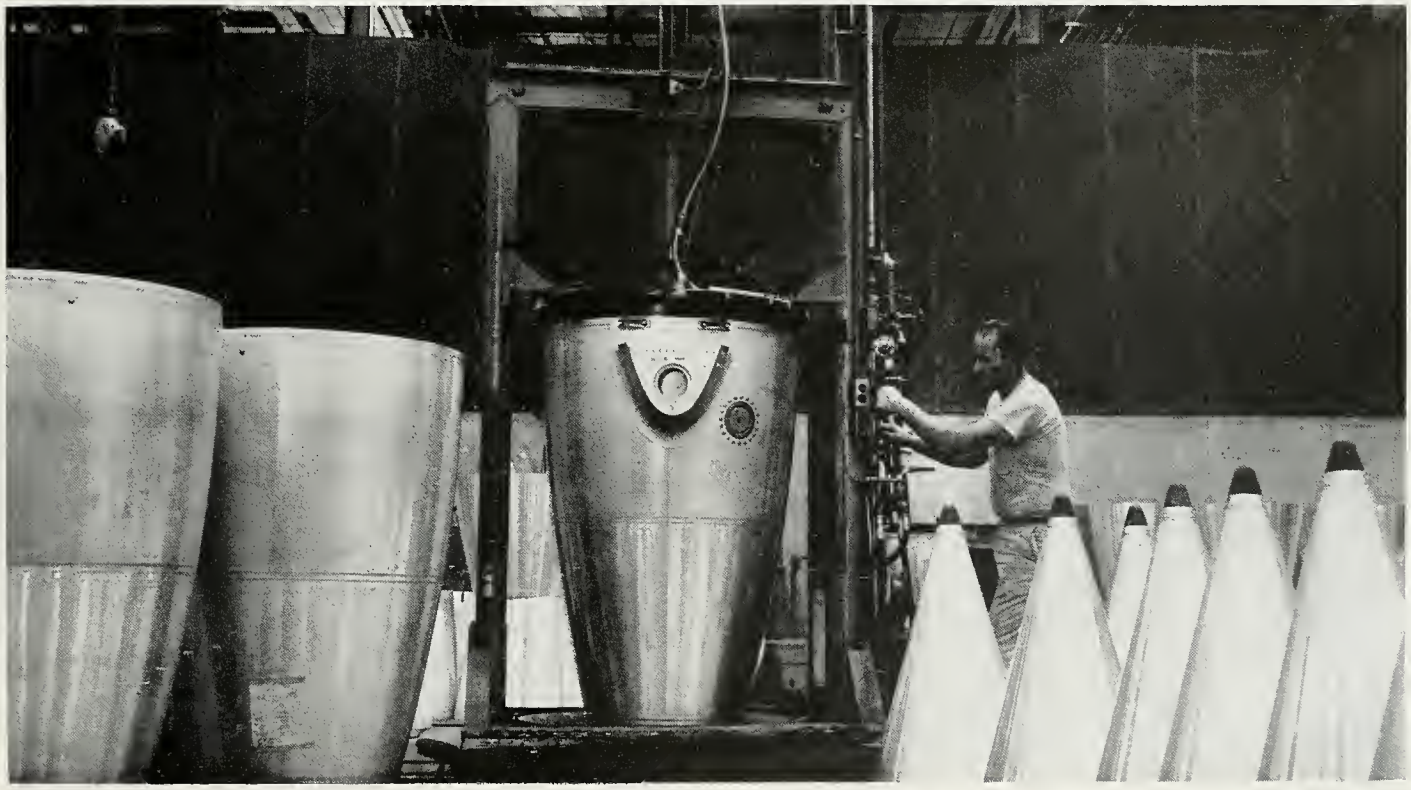
Ryan tanks extend the range of KC-97's which extend the range of combat planes

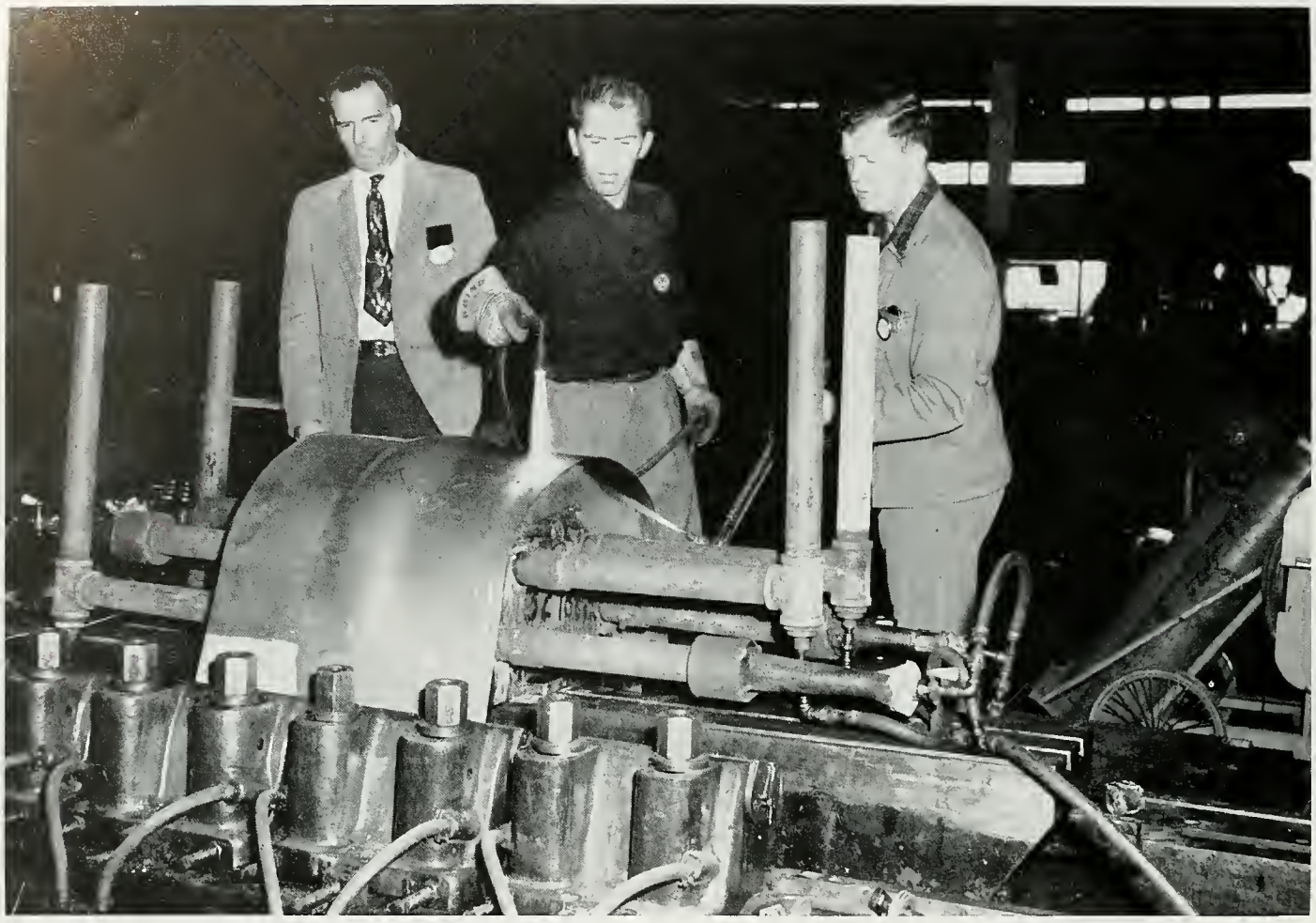
RYAN is building huge wing tanks for Boeing KC-97 Stratofreighters. These mammoth torpedo-like containers are stretching the range of the big aerial tankers to help them make a mid-air refueling on an average of once every 15 minutes around the clock.

The gleaming cells are a striking example of Ryan engineering and production teamwork. Through close coordination between these divisions, Ryan has developed a tank design which is outstanding in light-weight, high strength, simplicity and gas-tightness. The design objective was to create a tank which would meet all of the high requirements of Boeing and the Air Force and lend itself to sound fabrication methods.

KC-97 wing tanks must carry hundreds of gallons of aromatic fuel at 350 miles per hour. They must withstand every G-load, sloshing impact and vibration caused by flight maneuvers. They are subjected to rigid furnace-hot and ice-cold temperature tests. They must be immune to leakage and damage under these tortuous conditions. Their weight must be kept to a minimum. *(Continued on Page 22)*

Norris Root pressure tests Ryan tank sections in special fixture. All components must be spot welded gas-tight without sealers.



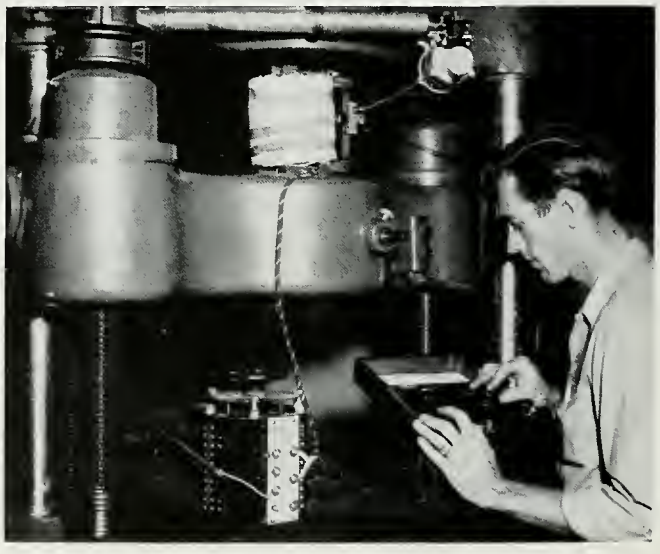


Ryan laboratory engineers experiment with the hot forming of titanium sheet on stretch press equipped with combustion-heated die.

TAMING TITANIUM

Ryan shrouded exhaust systems, with sections of titanium, are assembled for use with Piasecki helicopter engines. Titanium has performed well under these 500°F applications.

David Adams, Ryan metallurgist, directed most of the work of the Ryan titanium study. Here, Adams conducts a tensile test of titanium at temperature induced by electric current.



UNDER a prime contract with the U. S. Air Force, Ryan has just completed a comprehensive study of titanium. In what may be the most extensive report of its type, the results of this investigation will be made available to the aircraft industry. The objective is to familiarize industry plants with the best methods for fabricating airframe and engine components from titanium.

Conducted by Ryan's Engineering Division, the study was restricted to sheet metal manufacturing techniques and commercially pure titanium. Every process involved in sheet metal fabrication, such as forming, welding, riveting, grinding, sawing, drilling, cleaning, annealing and dimpling was analyzed.

Although metallurgical methods were generously employed to determine results, the study is not intended to be a theoretical metallurgical inquiry into the reasons why titanium behaves as it does. Emphasis is placed upon the practical question of how to apply manufacturing techniques to titanium sheet. As much as possible, standard aircraft machines and facilities are used to evaluate methods so that the information can be directly applied. Comparisons are drawn between recommended methods for fabricating titanium and those used with stainless steel.

Ryan is well equipped to make this study because of the extended experience which the company has accumulated in fabricating sheet metal, heat-resistant alloys. Then, too, Ryan is unique in that the company is both a prime and subcontractor and builds for both aircraft and engine applications. Thus, the information developed by Ryan has the broadest possible application to all types of companies within the aircraft industry classification.

An important advantage of the report stems from the fact that it is a coordinated, packaged study covering all phases of the manufacturing problem. Much has been written about titanium. Most of the data published is confined to a single fabrication method or is a highly specialized inquiry into one

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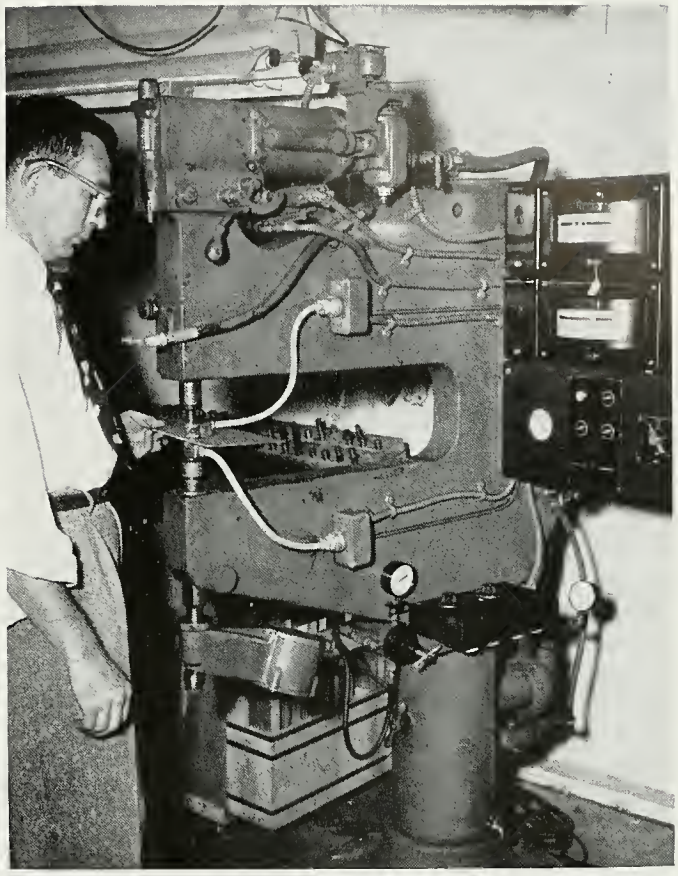
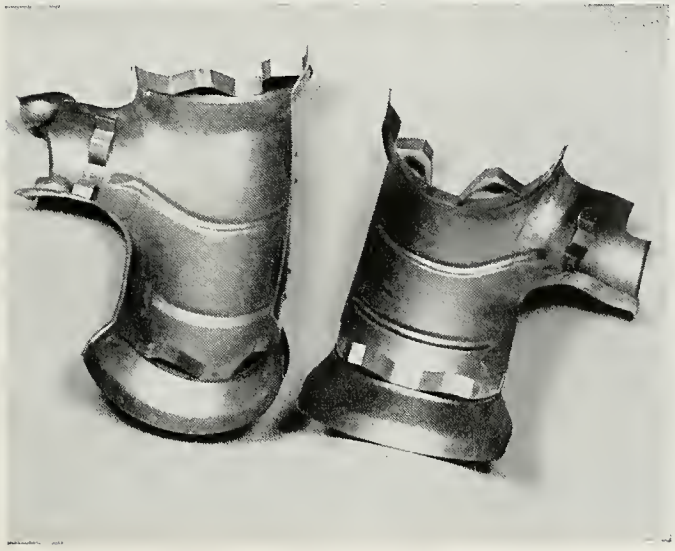


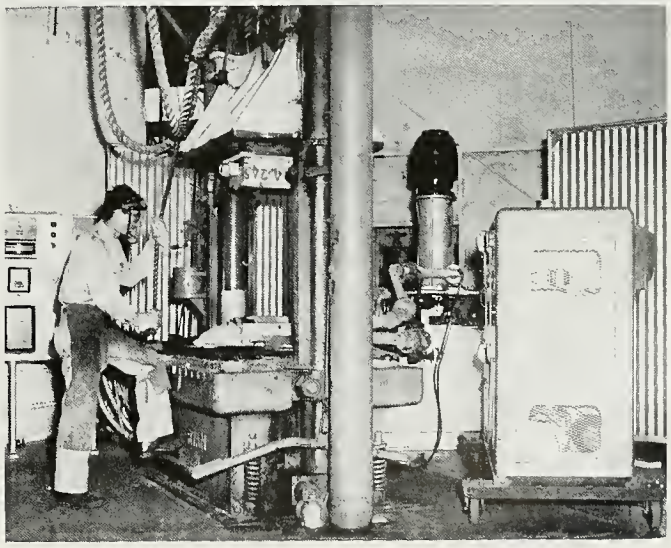
Dimpling investigations showed that titanium should be hot dimpled at temperatures between 600° and 700°F. This machine heats dimpling dies by means of encircling electric coils.

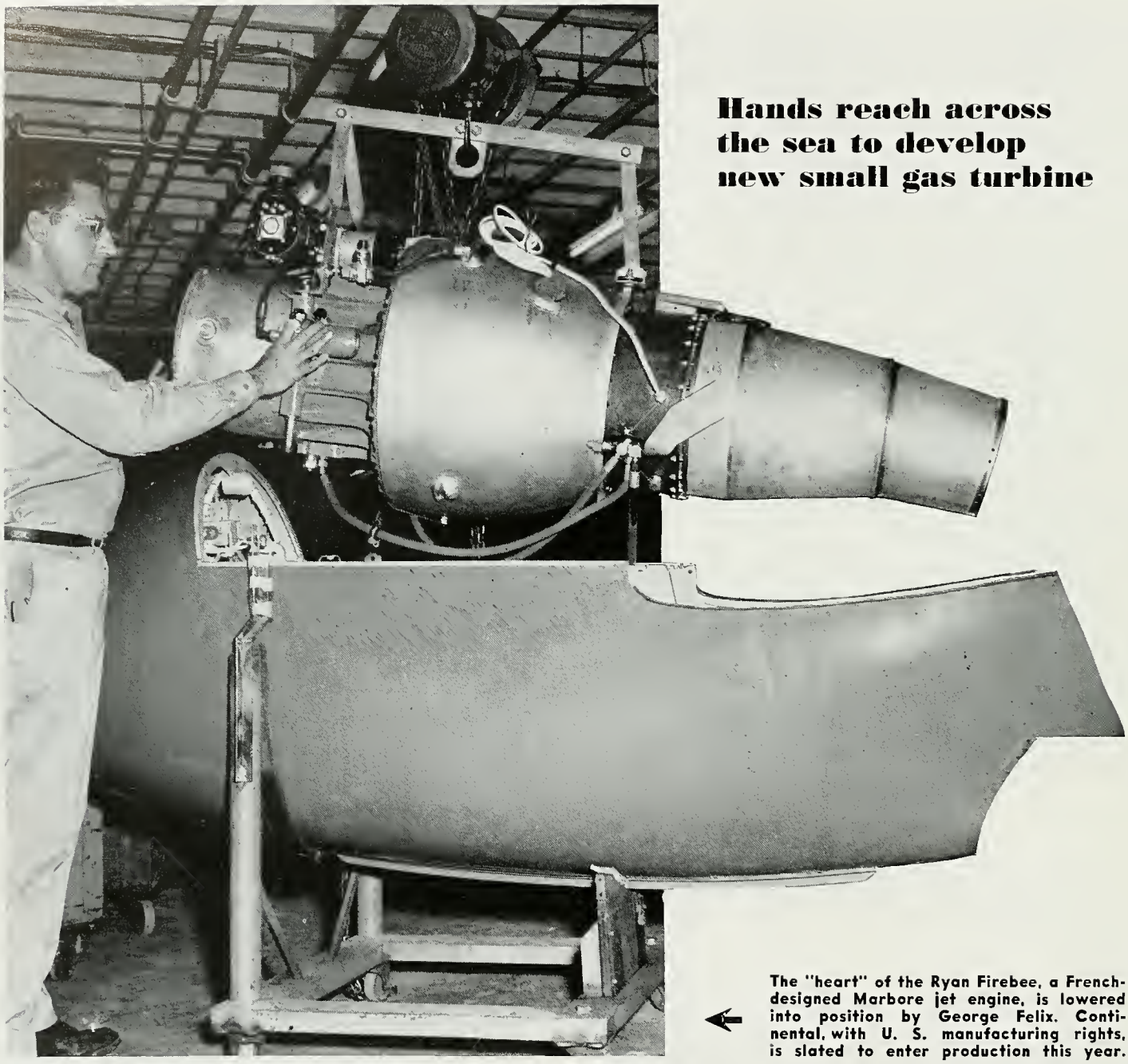
The Air Force and Ryan team together to put the harness on a long admired but little used maverick metal

Titanium shroud sections for Piasecki helicopter engines exhibit variety of manufacturing methods. These have been hot and cold formed, riveted and resistance welded by Ryan.



Drop hammer and die heater setup used by Ryan to evaulate titanium forming techniques. Die is heated by molten salt circulated from furnace. Punch is heated by electricity.





Hands reach across the sea to develop new small gas turbine

The "heart" of the Ryan Firebee, a French-designed Marbore jet engine, is lowered into position by George Felix. Continental, with U. S. manufacturing rights, is slated to enter production this year.

THE CONTINENTAL W

DEVELOPMENT of the Ryan Firebee pilotless jet target plane may in part be considered an example of international cooperation with one of our allies.

One of the highly efficient engines used in the intensive testing program at Holloman Air Development Center, Alamogordo, N. M. is the French-built Marbore, one of nine models of the Societe Turbomeca of Bordes, France, for which Continental Aviation and Engineering Corp. of Muskegon, Michigan, has obtained U. S. production rights.

"Americanization" of the Marbore is being expedited at Continental to effect quantity production this year. Under this program, in which all blueprints had to be converted from the French metric system to the U. S. equivalents, the engine has been steadily improved.

A number of the key assemblies for the Continental-Marbore engine are being built at Ryan. These are the cone, diffuser, nozzle and shell assemblies which are welded and machined structures with extremely close tolerances.

The earliest engine, the Marbore I, developed only 660 pounds thrust. The Marbore II, when received in the United States at Continental, was capable of 880 pounds thrust. Continental up-rated this engine to 925 pounds thrust by operating it at higher rpm and greater tailpipe tem-

peratures. To attain the present 1000 pounds thrust, Continental changed the design of some of the components and modified the aft end of the engine to make it compatible with the higher mass flow. The engine slated for production, and containing the latest refinements, is designated by the Air Force as the J69-T-19.

France made an early bid for leadership in the small gas turbine engine field, as applied not only to fixed-wing aircraft and drones, but also to helicopters, guided missiles and convertiplanes.

Soon after World War II, Turbomeca, encouraged by the French Air Ministry, began experimenting with small jet engines adaptable to trainers, as well as to small private planes. Fullest potentialities of the small gas turbine are still being explored, both in this country and abroad.

All Turbomeca models employ a single centrifugal compressor, a novel annular combustion chamber and a single-stage turbine. The Continental models have Americanized fittings, and the newest engines have added altitude compensation as part of the fuel system, providing a bias that works in conjunction with the centrifugal governor to maintain constant engine RPM with altitude variations. The Continental J69-T-19 has improved endurance, better altitude characteristics, lower specific fuel consumption, and generally greater efficiency than the earlier models.

A fundamental difficulty in developing a small gas turbine is the great accuracy required throughout the engine, particularly in the rotating parts. To compensate for this, components can be readily machined to much finer tolerances than can parts of a larger engine, and the increased rigidity of the engine as a whole helps in maintaining small clearances.

At Continental, an expanded engineering and technical staff is devoting considerable research to the use of the small gas turbine in helicopters, guided missiles, convertiplanes, trainer planes, cargo carriers, and other types of aircraft. In addition, several companies in the ground transportation and industrial equipment fields have asked Continental to help in experimental use.

Tests performed by the Flying Tigers airfreight line have established that the

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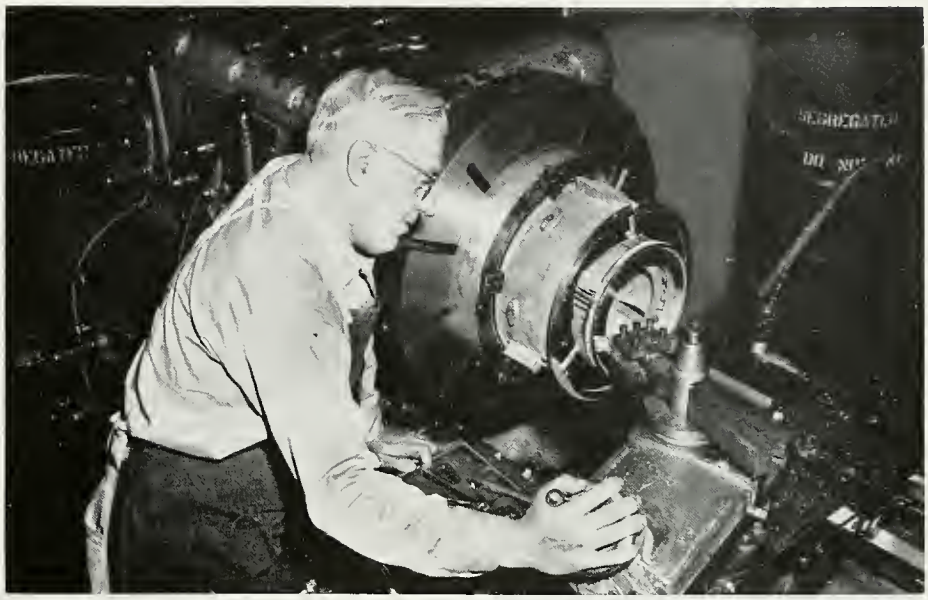
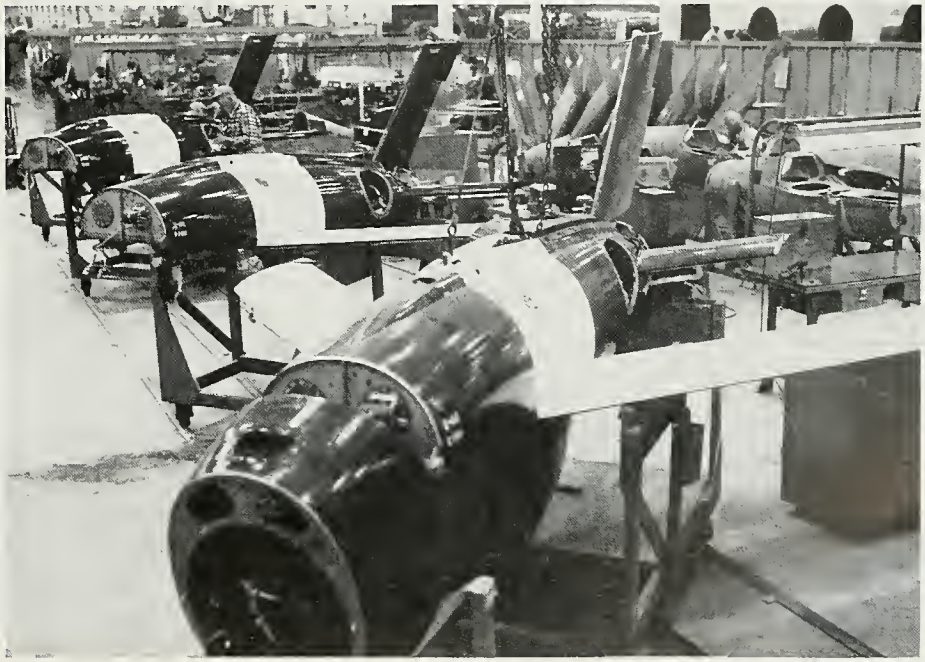
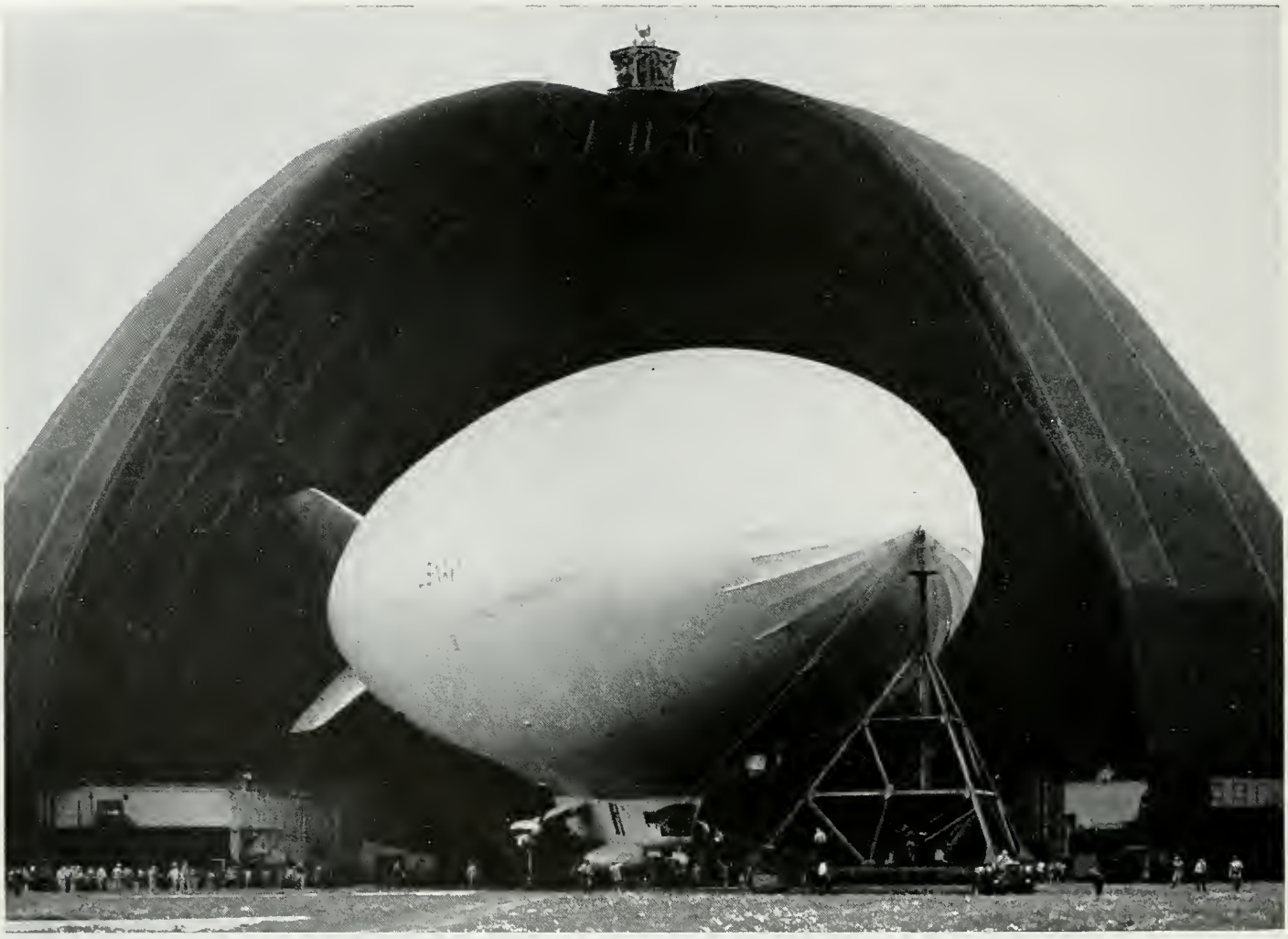


ABOVE:
Machinist P.E.G. Chartier works on inner ring of Continental J-69 diffuser assembly, one of several components of this engine being manufactured by Ryan. The parts require extremely close tolerances.

Welding on diffuser assembly is done by Martin Richter. Other welded and machined structures built by Ryan for Continental J-69 engines are cones, nozzles and shells. Engine has 1000 lbs. thrust.

BELOW:
Firebees are produced on assembly lines at Ryan's San Diego plant for all three services, the Air Force, Army Ordnance and Navy. Tests are being conducted to determine suitability as target drones.





Goodyear Aircraft's huge ZPG-2 Navy blimp dwarfs the tractor pulling it from its gigantic hangar prior to record-breaking flight.

RECORD SET WITH RYAN EXHAUSTS

Navy crew, Goodyear blimp and Ryan exhausts stay aloft for eight days

CRUISING steadily for well over a week on a patrol over the Atlantic seaboard, the Caribbean and the Gulf of Mexico, a U. S. Navy blimp—equipped with Ryan exhaust systems—recently established a new world's endurance record for a non-stop flight of aircraft and crew without refueling.

The lighter-than-air craft and its crew of fourteen landed at Key West, Florida, 200.2 hours after departing the Lakehurst, N. J., Naval Air Station. During this period, the airship covered more than 3,000 miles while on a simulated anti-submarine patrol. The old record of 170.3 hours was set in 1947 by an M-type airship flying out of NAS Lakehurst.

The ZPG-2 is a non-rigid airship of the N-type built by the Goodyear Aircraft Corporation, Akron, Ohio. It has the latest developments adaptable to aircraft for locating and attacking enemy submarines. Special equipment aboard the big ship makes it possible to refuel in flight by taking on fuel from a surface

(Continued on Page 22)

ZPG-2 exhaust system is collector type with flexible tail-pipe. Ryan's Robert Chase points to ball-and-socket joint.

TWO-WAY STRETCH

By pulling in opposite directions, Ryan's new stretch presses add inches and curves to skins and extrusions

FOR the shape it's in, many an aircraft part can thank the stretching operation, in which ponderous jaws and rams function with an exquisitely sensitive touch. Inches are added to skins and extrusions while desired contours are formed. The miracle of stretching metal as though it were an elastic band is performed with matter-of-fact precision every day in thousands of plants.

At Ryan Aeronautical Company, two giant stretch presses have gone into operation within the past year, but the principle of stretch-forming is an old one here. Ryan was one of the pioneers in the use of mandrels for forming circular shapes, and now is a leader in the utilization of this type of equipment. Mandrel-sizing work involves the same principle as does stretching on the two new Sheridan presses and the veteran Erco press in use at Ryan. The major difference is the end product of the mandrel—a circular item.

Until installation of the Sheridan presses, most stretch operations were performed for Ryan by outside contractors, some as far distant as Dallas, at considerable expense. Today virtually all such work has been pulled into the Ryan plant with savings so substantial that the presses are literally paying for themselves. The cost incidentally, is a sizeable item—$28,500 for the table type extrusion press, and $60,000 for the sheet, or "skin," stretch press.

The larger of the two presses, with a stretching capacity of 90 tons, is being used to stretch "skins" for the Boeing KC-97 aft fuselage sections, of which Ryan is the sole supplier. To accommodate this mammoth piece of machinery, a pit 50 feet long at maximum length, 14 feet wide and with a maximum depth of 11 feet, 9 inches had to be excavated.

The jaws in this press pull the aluminum "skin" taut as three hydraulically operated rams force up the table on which rests the die in the desired contour. The jaws then stretch-wrap the skin around the forming die.

The smaller Sheridan, with a 10-ton stretching capacity, is employed to form extruded parts, also primarily for the KC-97 fuselage. The operating principle is the same, except that the single ram is horizontal and pushes the die table forward against the hydraulic pressure of the jaws, which pull the component, wrapping it around the die.

An Erco stretch press, the oldest of its kind in the Ryan factory, has been used for years in stretching skins with both hot and cold dies. The Erco's jaws, in contrast with those of the Sheridans, are stationary, and are situated parallel to the ram. Such skins as those enclosing the KC-97 refueling pod are shaped on this press.

The jaws lock the skin into position, hold it rigidly and the ram, pushing up on the die table, stretches the metal into the shape required. Certain metals, such as magnesium and titanium, must be stretched on hot dies, and the Erco is therefore used for stretching magnesium skins of the Ryan Firebee pilotless jet-propelled target drone. Experimental work

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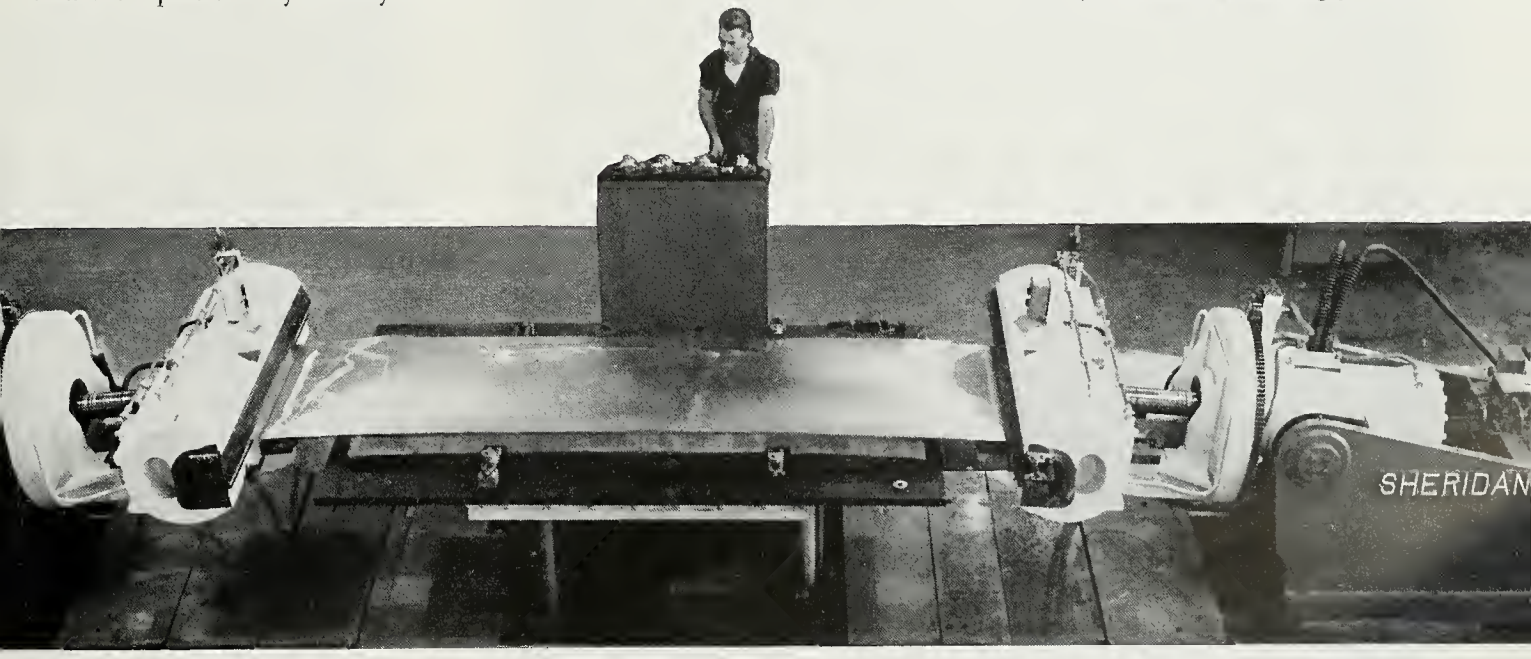


Skins for KC-97 fuselage sections are stretched into desired forms on Ryan's new Sheridan press with 90-ton stretching capacity.

with titanium also has been done on the Erco press. The hot dies are built with tubes containing gas burners that maintain a required temperature as the stretching is under way.

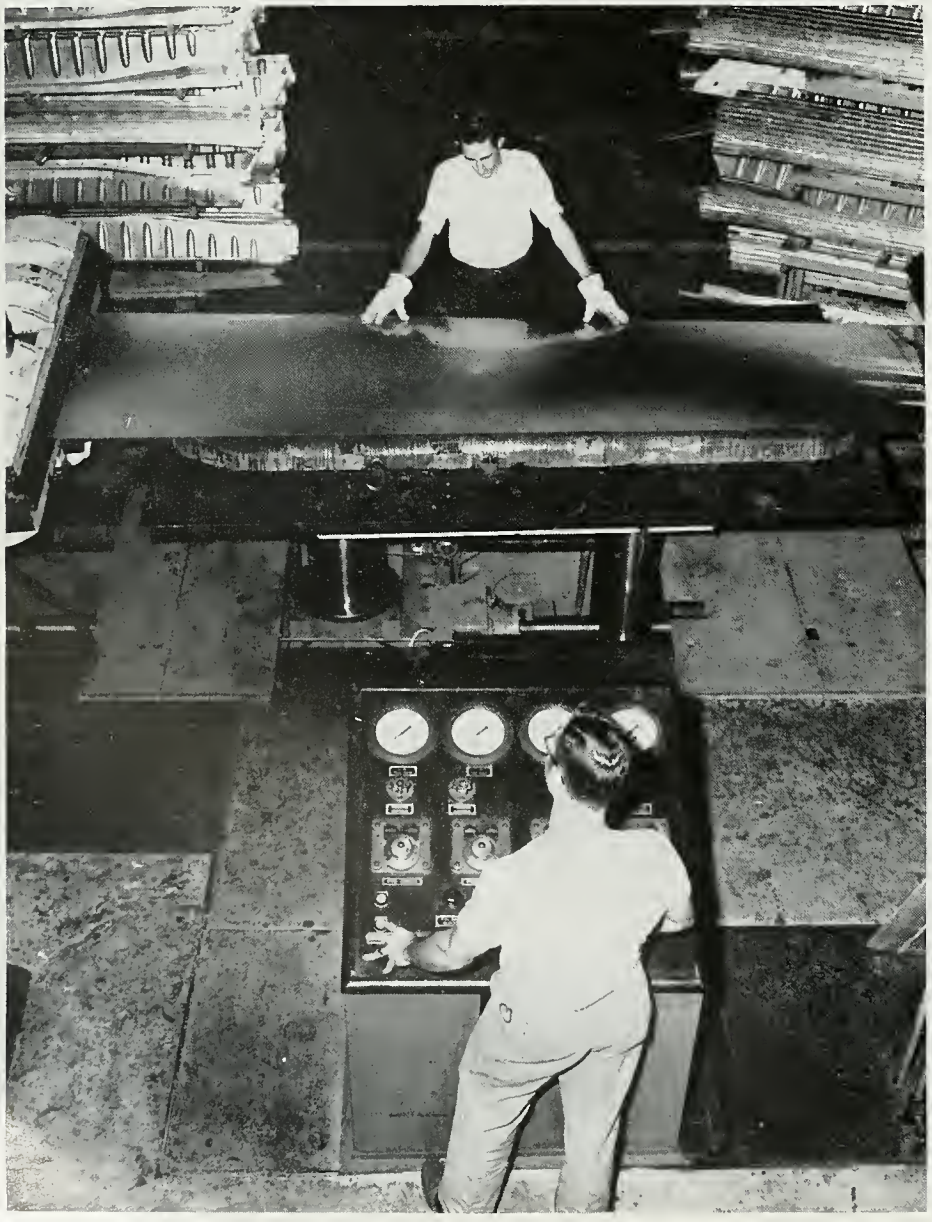
A stretch bench, built by Ryan, has been employed for a long time to straighten various types of parts that may be warped after heat treating. This is a simple technique in which one jaw remains stationary while another jaw pulls the part.

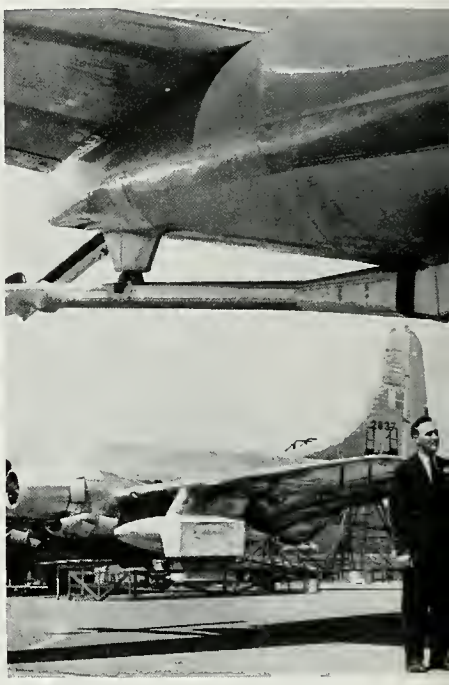
Stretching is performed within certain limitations such as thinning of the metal. These tolerances and the degree of angles and the length of flanges are established by Ryan's engineering department and closely checked by inspection. Seldom is it necessary to exceed more than one half the available elongation—the maximum stretch before reaching the breaking point—in order to form the average part.

Stretch-forming has numerous advantages. Obviously, it replaces a great deal of handwork needed in other methods. Contouring of parts by hand would be required if parts were formed in the hydropress, brake press or power rolls, which are unable to produce parts with complete contours. Parts can be formed ready for installation in the assembly after leaving the stretch press.

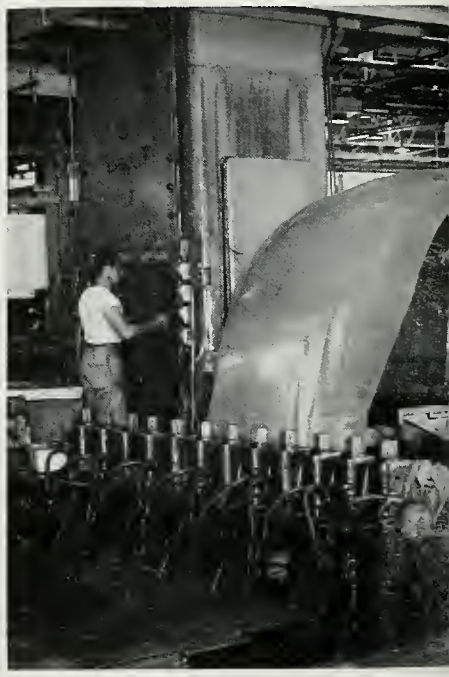
Because parts are under constant tension as they are stretched, forming can be accomplished without wrinkling, as often

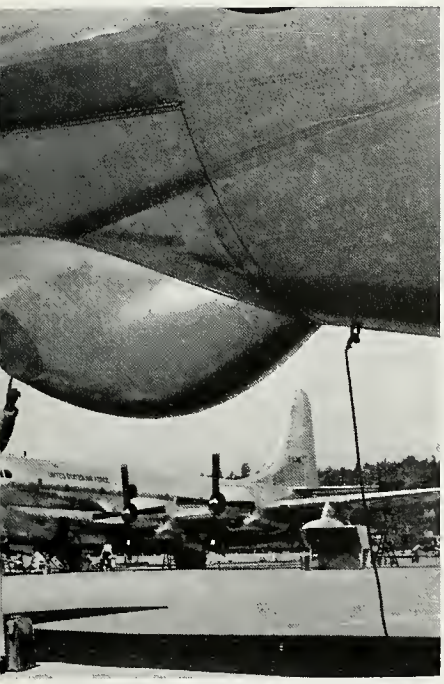
Most stretch operations were performed for Ryan by outside contractors until acquisition in recent months of equipment such as this Sheridan press shown in operation.



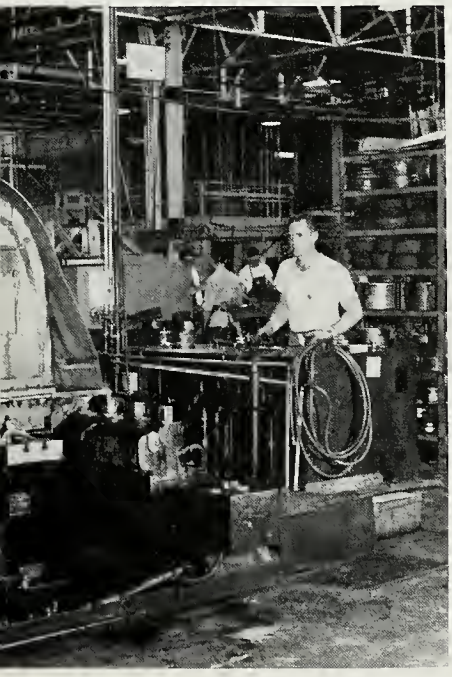


Curved shapes of aircraft components such as pod assembly for Boeing KC-97 aerial tanker, to which Ryan representative John Cameron is pointing, above, depend on stretch press for forming. Pod is attached to belly of plane to provide station for man who operates "Flying Boom" in midair refueling operations. Ryan has been chief supplier of pods and aft fuselage sections of KC-97 in production program extending over several years.





KC-97 refueling pad skins are formed at Ryan Aeronautical Company on its first stretch press, an Erca, which has been in operation for some time. Jaws of this press, in contrast with the Sheridans, are stationary and are situated parallel to the ram. This press is equipped to use hot, as well as cold dies, and is therefore used for stretching magnesium skins, such as those on the Ryan Firebee pilotless, jet-propelled target dranes.



occurs in other operations.

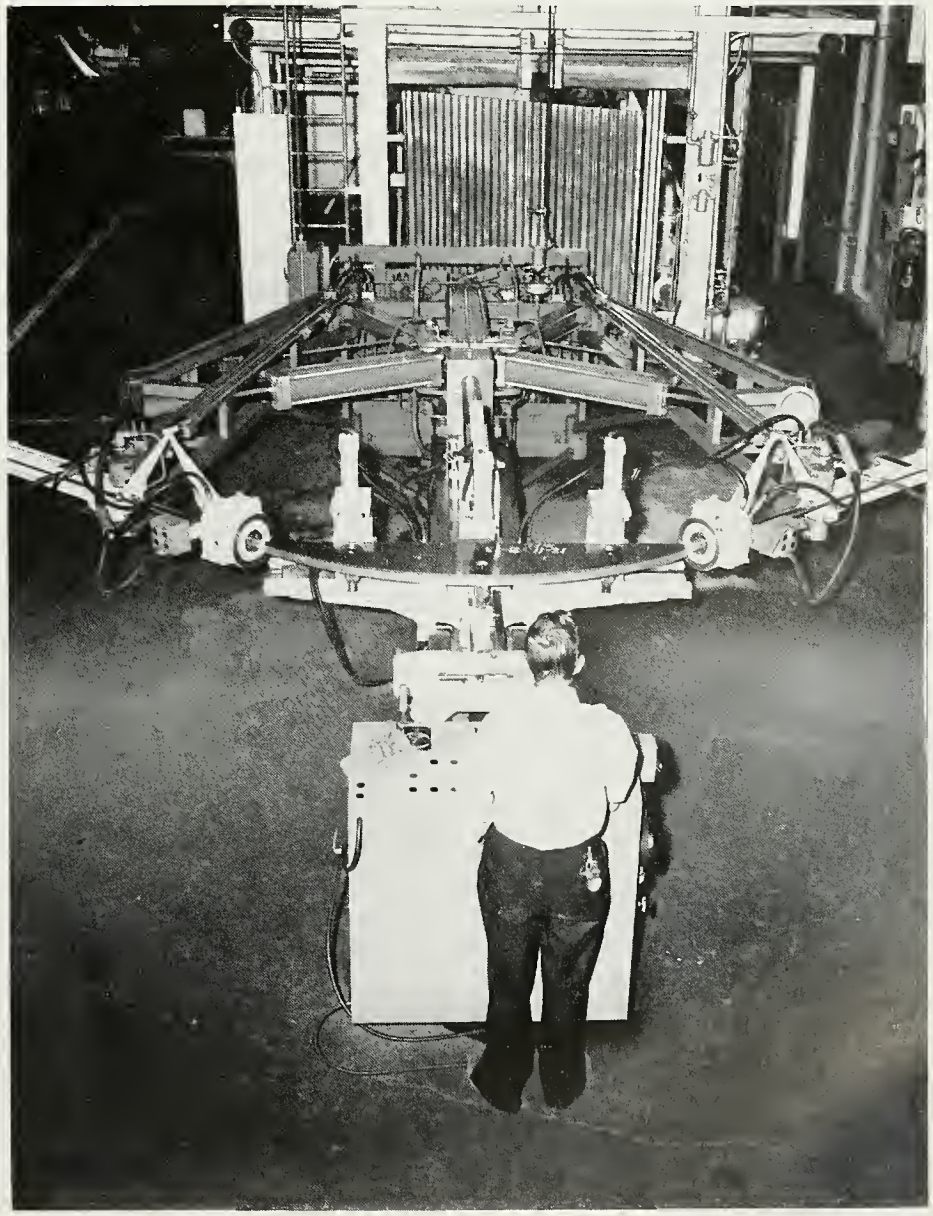
Finally, parts are somewhat strengthened through the work-hardening that results. Stretching increases the yield strength of the material to a point at which the metal takes on a permanent "set." Although ductility decreases, a sufficient percentage of such elongation characteristics is maintained to provide ductile properties for engineering applications.

Airframe production has probably given the stretch press operation its greatest boost. In such high quantity mass production industries as the automotive, huge and expensive hydropress tooling is economically feasible for the output of hundreds of thousands of parts.

But in the production of airframes, where the number of comparatively large parts is more likely to be counted in the hundreds, stretch press use is an ideal compromise. Though inherently slower than crank or hydraulic presses, it is considerably faster than handwork. At the same time, the stretch press machine is much less expensive than the large presses. For the forming of a few hundred, or a few thousand parts, a stretch press is ideally suited to the unique production problems of the aircraft industry.

Ryan is making parts go a long way by stretching them, a technique proved successful in the increasingly complex business of producing aircraft.

Smaller of two new Sheridan stretch presses is this machine, with 10-ton stretching capacity, used to form extruded parts. Total cost of two presses was almost $90,000.



Panoramic view of sprawling missile test and evaluation facilities of the Naval Air Missile Test Center at Point Mugu, California.

Proving Ground of the Future

Aerial weapons of tomorrow are flying today at Point Mugu

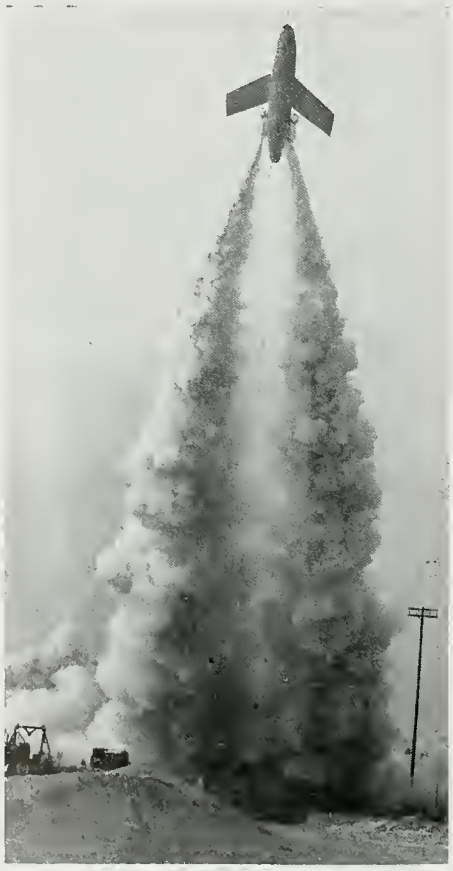
VISIBLE evidence that the push-button warfare fantasies of the science fiction writers are beginning to fall within the clutch of man's technical ability can be found at the Naval Air Missile Test Center, Point Mugu, California. Here, the guided missile weapons of tomorrow's Navy are being test flown today.

Located near the extreme southern tip of the Santa Clara River mouth approximately 55 miles north of metropolitan Los Angeles, the Naval Air Missile Test Center (NAMTC) passes judgment on the guided missile products of the U. S. Navy's Bureau of Aeronautics. This is the place where such new devices as Ryan's remote-controlled Firebee pilotless jet target drone are rigorously tested.

Guided missiles are a comparatively new innovation in aerial warfare. The German V-weapons that blasted England in the closing days of the second World War served to awaken the allies to the potential of missile warfare. This "awakening" touched off what amounted to a technological revolution in aviation that has changed the shape of airpower.

It is on this expanding technical frontier of aviation that the NAMTC is fighting its share of the battle for qualitative air supremacy. Its mission: To test and evaluate guided missiles and their components.

The NAMTC at Point Mugu is the Bureau of Aeronautic's over-water guided missile test range for missiles designed to travel both short and long distances. It complements the Air Force Missile Test Center at Cocoa, Florida, and the Army's White Sands Proving Ground in New Mexico.



Navy Regulus surface-to-surface missile trails twin streams of smoke from rocket assist take-off battles while undergoing tests at Naval Air Missile Test Center.

Few people, even among the specialist employees assigned at the Center itself, have a clear picture of the wide variety of projects that are under evaluation at this huge installation. Most of NAMTC's work is necessarily obscured by the cloak of military secrecy. But it is well-known that the Navy has reached the advanced stages in the development of such missiles as the Regulus and the Sparrow.

The Missile Test Center was originally conceived during World War II when the Navy realized that the new weapons then under development would need extensive areas of land and water for proving grounds. Accordingly, the Chief of Naval Operations, on recommendation of the Chief of the Bureau of Aeronautics, appointed an informal board of officers to determine the requirements of such an installation, then select the site.

After an exhaustive survey of the coastal areas of the United States and the Caribbean, the board selected Point Mugu as an ideal location for missile test work. The board's approval was adopted, and on October 1, 1946, the NAMTC was established.

A significant factor in the choice of

the site was the proximity of the Channel Islands, which stretch majestically against the western horizon off Point Mugu. Several of these islands are equipped with precise radar, optical and photographic tracking devices, insuring a continuous and accurate record of a missile's course once it has been launched from Point Mugu. The island tracking facilities are also utilized by missile launching ships, such as the guided missile ship "Norton Sound."

Outguard of the group, and most important to the work of NAMTC, is San Nicolas, a barren, windswept island of sandstone lying more than 50 miles off the mainland. "San Nick"—as it is called by those who serve there—was formally commissioned as a part of NAMTC in December, 1946. It has an airstrip and a permanent complement of NAMTC personnel.

In the years following the establishment of the NAMTC, the area at Point Mugu has grown from a few huts scattered on the beach to a modern city covering more than a thousand acres. The Navy has spent a total of $37,000,000 on construction, real estate and equipment, and an additional $10,000,000 has been allocated for further construction. It has been estimated that the installation will have a $75,000,000 value, eventually.

The Point Mugu of today is a far cry from the quiet lagoon and Indian village that greeted the eyes of the famed California explorer, Juan Rodriquez Cabrillo, some 400 years ago. The friendly Chumash Indians living there at the time promptly dubbed the site of his landing "Mugu," which in their language meant "Place of Landing."

Today, the "Place of Landing" could perhaps be more appropriately described as a "place of take-off." Cabrillo's quiet beach is now seared, day after day, by great blasts of flame and smoke as the Regulus and other guided missiles streak seaward from NAMTC's launching pads.

Missiles take many forms. Some look like modern jet fighter planes and others look like huge shells with stabilizing fins. Each is designed for a specific mission that would fall into one of the following categories: air-to-air, air-to-surface, air-to-underwater, surface-to-air, and surface-to-surface.

No matter what their shape or mission, they all have one thing in common. They are very complex and, at present, expensive. A serious handicap in guided missile testing at Point Mugu and elsewhere is the fact that a pilot can't go along to make notes during test flights. As a result, special telemetering equipment must be designed so that the results of a brief missile flight can be recorded and interpreted.

The launching of a guided missile at Point Mugu is, understandably, a major operation. Before an actual firing can take place, hundreds of details must be checked and double-checked. The malfunction of a single fifty-cent vacuum

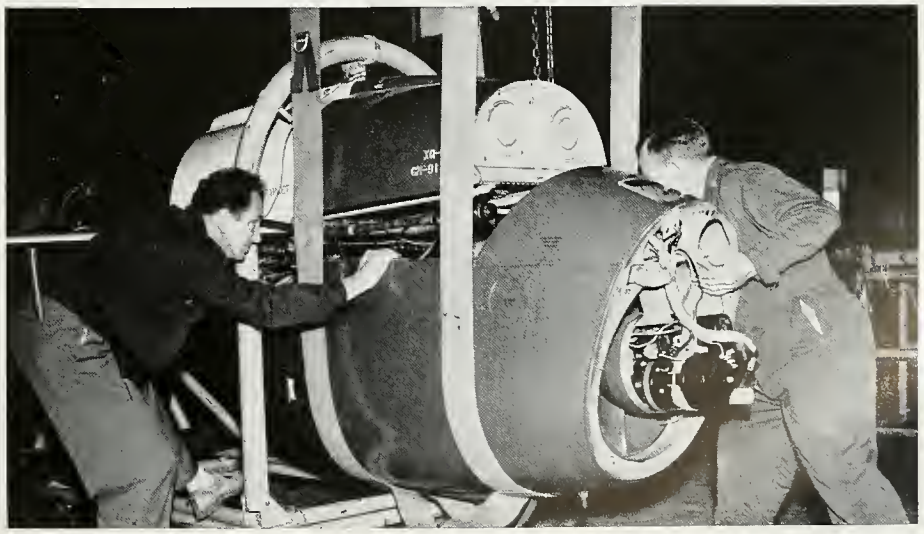
(Continued on Page 32)

Ryan KDA-1 Firebee is hoisted aboard a target retrieving boat off Point Mugu during a simulated sea recovery test. Most NAMTC Firebee flights will be conducted over water.

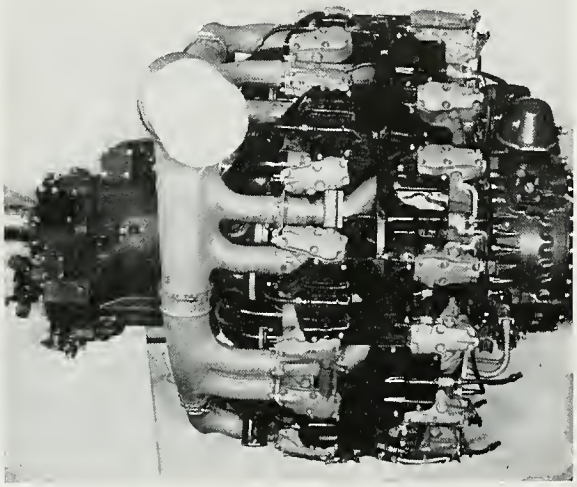
Test flight of Lark missile as seen on a Recordak machine. Films of launchings are passed over a lighted screen for viewing.

OFFICIAL U. S. NAVY PHOTOS

Ryan personnel at the Naval Air Missile Test Center hoist Firebee engine nacelle into place on fuselage in preparation for flight tests. Nacelle houses Fairchild J-44 jet.



BELL HSL-1 IS RYAN EQUIPPED



Bell helicopter power plants are Pratt and Whitney Aircraft engines fitted with Ryan exhaust systems. These 18-cylinder engines are similar to those used in Convair 340 and Douglas DC-6 airliners, also equipped with Ryan high temperature exhaust units.

ANOTHER new helicopter—the Bell HSL-1—is taking to the air with Ryan exhaust equipment. Now in volume production in Bell's Fort Worth plant, the HSL-1 is the Navy's most powerful helicopter and the first specifically designed for anti-submarine warfare

The HSL-1 is a result of the Navy's attempt to find an effective counter for the ravages of World War II submarines which torpedoed ships faster than they could be built. Bell was awarded a contract for the HSL-1 by winning a Navy competition in which eight rotary wing aircraft builders took part.

An unusual feature of the new machine is its high power-to-weight-and-size ratio. It is equipped with a Pratt and Whitney Aircraft R-2800-50 engine which drives two large contra-rotating rotors. For the substantial amount of power which this Double Wasp engine develops, the HSL-1's fuselage appears to be amazingly modest.

(Continued on next Page)

BELL HELICOPTER

(Continued from Page 20)

There is a definite objective in this apparent anomaly. With folding rotor blades and compact size, the HSL-1 fits neatly into elevator holds and can easily be stowed below most any carrier deck. Then, the stepped up power, coupled with high disc loading and high rotor tip speed, provides maximum performance in lift and cruising speed. Official figures have not been released, but it is reported that the helicopter can carry over 4000 pounds of search radar, sonobuoys and similar anti-submarine gear. Its top speed should be equally exceptional.

HSL-1 engines are served by collector-type exhaust systems which are designed and built by Ryan. Made from formed and welded stainless steel, these large structures pipe flaming exhaust gases from the engine's 18 cylinders and eject them safely to the atmosphere. Incidentally, the HSL-1 engine is the same basic type used in Douglas DC-6 and Convair 240 and 340 airliners, for which Ryan also builds exhaust equipment.

The HSL-1 is capable of all weather operation because of its inherent stability and the fact that standard equipment includes a Bell-designed autopilot. This device controls direction, altitude, pitch and roll but permits the pilot to override autopilot "commands" at any time.

As HLS-1's become available they should supplant some of the weapons now used by the Navy for anti-submarine work. These include "hunter-killer" task forces composed of carrier-based aircraft, four to six destroyers and even a blimp.

Most aircraft used on this work do not carry equipment to act as both detector and destroyer of subs so that at least two planes are employed. Often, destroyers must be called upon to make the "kill" while the planes circle the area maintaining contact through sonobuoys.

With HSL-1's operating singly or in pairs, it will be possible to perform these tasks more efficiently. Helicopters are not affected by weather conditions as much as faster flying aircraft. Operating closer to the water, they can use sonar devices more effectively to maintain contact with an enemy submarine. Their hovering ability allows them to stay in one area and to transfer contact to surface ships with relative ease.

Constant improvement in effectiveness of submarines, such as schnorkel breathing devices and long range atomic power plants, have made them harder than ever to detect. The Navy has developed the Bell HSL-1 as a potent counter measure to meet this increased threat.

Aerodynamicists and mathematicians from Ryan's Engineering Division watch instructor Julian Kainer use Ryan's newly acquired $58,000 analyzer.

Engineers Get Newest Electronic "Thinking Machines"

Science's newest "thinking machines" are being called upon by Ryan to augment the manpower of the extensive Engineering Division. An elaborate array of electronic marvels is being installed to speed the solution of complex engineering problems and assist in the analysis of flight situations.

With these mathematical automatons, Ryan engineers will be able to obtain solutions for technical questions in hours or days which would otherwise require years to procure.

Most expensive new machine in the group is a $58,000 electronic differential analyzer made by Goodyear. Ryan aerodynamicists will feed design formulae into this machine and get answers concerning actual flight limitations with fantastic accuracy and brevity.

Groups of Ryan engineers are being trained in the plant and at Northrop Aircraft Company by special instructors.

Ryan engineers gather around Northrop instructor Tom Eason (fourth from left) while he explains workings of an IBM electronic computer.

GOODYEAR BLIMP

(Continued from Page 14)

craft, or to re-ballast by taking on water from the ocean through a water pick-up system.

It is powered by two 800 h.p. Wright Cyclone 7 engines equipped with Ryan-built collector-type exhaust systems. The engines are mounted in an engine room within the two-deck control car. They drive a pair of three-bladed Curtiss Electric, reversible propellers mounted on outriggers projecting from each side of the car.

A series of shafts and gears transmit the power to the propellers and, when desirable, one engine can drive both. Both engines are accessible for maintenance and repair in flight, if necessary.

In command of the ZPG-2 during its record-breaking patrol was Navy Cmdr. Marion H. Eppes of Pinson, Alabama. The morale of the crew during the long flight was very good in spite of a fresh water shortage which developed when an auxiliary water container became contaminated.

In addition to the record-setting ZPG-2, Ryan exhaust systems are utilized on the majority of the blimps in use today. These include the K-type, M-type, the ZPN, ZP2N, ZP4K, ZP5K and the ZPM.

KC-97 FUEL TANKS

(Continued from Page 9)

Boeing outlined the basic tank requirements. These included capacity, dimensions and contours. Given these and the Air Force requirements, Ryan engineers designed the tank structure, fusing engineering and production know-how at every step.

Several years ago, Ryan developed a unique and highly successful tank design with the creation of the big fuel tanks for the Boeing B-47 jet bomber. To keep weight down, the number of tank components was held to the lowest possible figure. This provided another salient advantage. Fewer components meant less metal thicknesses at joints and less difficulty in joining joints into gas-tight structures. But, the idea also presented some towering problems in fabrication.

First, how to make the tanks strong enough to meet the terrific demands imposed and yet simple and light in structure? Then, eliminating components, such as conventional quarter - section stampings, meant designing larger sections. This posed problems in getting access for welding. It required greater control of precision because larger sections would magnify slight errors in dimensions. But errors could not be tolerated because all of the big sections were to be joined by butt welds, for simplicity, and the big components must mate perfectly with each other at each joint.

Ryan solved these problems with a new tank-building technique and designed the structure to fit this method of fabrication. The tremendous B-47 tanks—largest wing tanks built—were designed to consist of a few huge circular sections joined together with light-weight spotwelding. Every longitudinal member was eliminated and only simple splice rings used at the welded joints. The big sections were stretched to exact diameter and trimmed to exact length by ingenious machines designed by Ryan. Results were extraordinarily successful.

For the KC-97 tanks, Ryan has drawn heavily upon the extensive experience gained in building the B-47 cells. The KC-97 containers consist of only five major circular sections joined with thousands of spotwelds. Bolting rings are used on three joints which are designed to separate for shipping purposes. No rivets mar the sleek, streamlining of the tank exterior.

There are no longitudinal members in the tank—not even stringers. Only two compact bulkheads are used and these are light-weight riveted assemblies which transmit the loads to the wing fittings. The structure is skin-stressed throughout its envelope of 61S aluminum alloy.

Tank sections consist of a spun nose and tail cone, two combination spinnings and welded-sheet sections and a welded-sheet center section. The nose section is a parabolic dome which attaches to the tank with a hexagonal, internal-wrenching bolt. It can be quickly removed to give complete access to the tank interior. The tail cone is a straight-sided cone which is equipped with a soft rubber tip to prevent wing damage in case the tank is inadvertently dropped.

First step in fabricating the big tank component is to roll the 61S alloy into circular sections, which are slightly undersize in diameter, and weld the longitudinal seam on automatic Heliarc machines. The resulting butt weld is almost undetectable because the metal thickness at the joint is the same as that of the parent metal. This provides a seam which can be run through resistance welding machines without special preparation.

After fusion welding the sections are heat treated in a modern elevator-type electric furnace which brings them up to 980°F. and quickly cools them by dousing them into a cold water spray. This renders the parts more ductile for forming and stretching.

The components are then stretched to diameter on Ryan-designed expanding mandrels. Among the largest of their type, these powerful machines employ a huge hydraulic ram which pulls a tapered pin through a segmented set of formed shoes. As the pin drops, the shoes expand stretching the sections to exact size. Tapers may also be formed by this method. Close precision, to .025" in diameter, can be obtained without difficulty.

Next step in the process involves the aging of the sections by heating them to 350°F. for 8 hours in a gas-fired oven to harden them and raise their yield and ultimate strength to the specified levels.

To trim the tank sections to exact length, another Ryan-devised machine is used. The sections are placed on a rotating drum and held firmly in place by air-filled tubes which expand against the inside of the parts. High speed routers move in and trim the edges of the component as it revolves between them on the drum. Lengths must be cut to .010" accuracy. Filler cap holes and other openings are blanked out in a hydraulic press. The components are now ready to be spotwelded.

Ryan is equipped with a bank of eight huge spotwelding machines which are among the nation's largest. These behemoths can make up to 200 spotwelds per minute, "fire" 120,000 amperes of current and exert 11,000 pounds of electrode force. They are capable of handling large sections because the electrode arms are 60 inches long and 62 inches above the floor. They were especially designed for work such as these large tanks.

The tank sections are joined together on these machines with circumferential welds which attach the components to splice rings. Each joint is given two rows of roll spot welds and two rows of seam-welds. All work is performed with wheel-type electrodes. Roll spot welds are made on 1.5-inch centers with electrode wheels stopping for each weld in brief, intermittent pauses. Seamwelds are a series of overlapping spotwelds, made while the wheels are continuously rolling. The result is a strong, gas-tight joint which is extremely light in weight.

Because of its good ductility, 61S aluminum is an excellent alloy for spotwelding. However, it must be thoroughly cleaned of all grease, soil and oxides beforehand. Slight amounts of soil and oxide film will alter the electrical resistance of the skins, cause temperature rises and burn-through of the metal.

Ryan developed a superior cleaning agent—RACO 34—which removes all soil and oxides with smooth uniformity. Daily records show that surface resistance is running between 10 and 15 microhms—

(Continued on next Page)

well below the 50 microhm limit required. Sheets are welded within 24 hours after cleaning because the oxide film will re-form within relatively short periods when the metal is exposed to air.

Each tank section is pressure tested, individually, to show that it is gas-tight. No sealing compounds may be used. In special Ryan fixtures, the sections are clamped shut with rubber-faced enclosures and pumped full of compressed air under 4.5 pounds per square inch pressure. Leak detecting compounds are sprayed on the exterior to disclose the slightest air leak.

When the tank is completely assembled, it is suspended in the air, and pressure tested again. This time it is pumped to 3.5 pounds per square inch and held under test for 45 minutes, to reveal slight leaks that would not be evident under limited test periods. A Ryan-devised manometer gauge is used to show pressure loss. This instrument is so sensitive that it will register a pressure drop of only one five-hundredth of a pound.

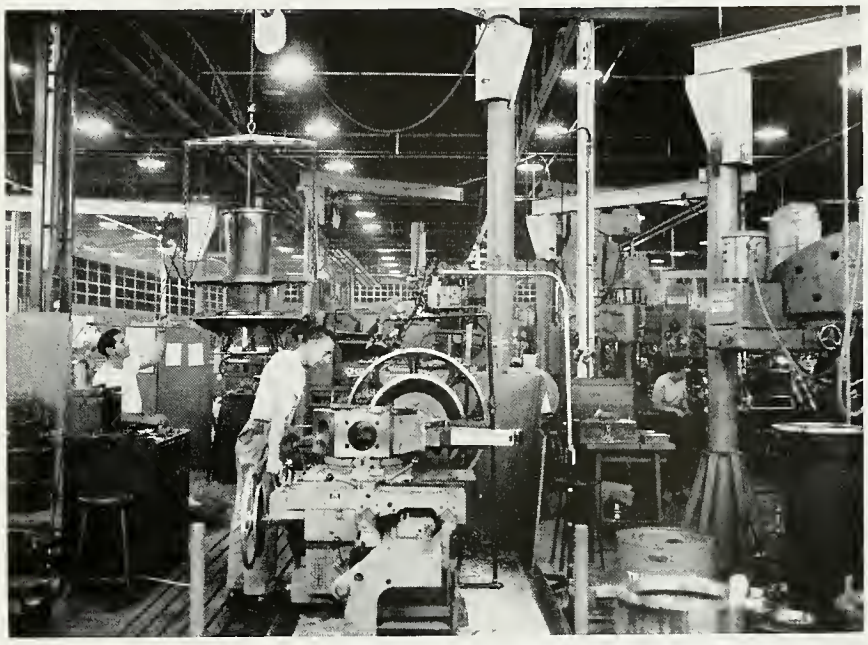
Machined aluminum alloy rings are used at the tank's break-a-way joints. These components must be machined flat on their mating surfaces to within .002" because they must fit together without more than .004" spacing at any point. This rigid requirement is insisted upon because the rings must prevent fuel leakage when bolted together even though temperatures range through 250°F.

The rings are drilled on special Ryan fixtures which employ Keller Airfeedrills. Holes must be located within .010" accuracy. Rings and bulkheads are drilled at the same time so that perfect coordination exists between them. The rings are spotwelded to tank sections using roll spot methods with welds spaced on ¾" centers.

The tanks must be interchangeable in all sections and tank strut fairings must fit all tanks. In one way, the tanks are more critical in dimension than the B-47 tanks which Ryan built. Tank attachment fittings extend over several sections in the KC-97 cell. Since these fittings are precisely spaced because of the wing requirements, this imposes exact tank section lengths and precision-interchangeability upon the fabricated components.

The design permits "nesting" of tank components, one within the other so that a tank may be shipped in a space of less than half its total volume.

Static tests of the structure were carried out by Ryan engineers. Tanks were placed in steel fixtures and tested with varying amounts of fuel by the application of loads in different directions. The required slosh and vibration tests were conducted at Boeing with Ryan engineers in observance.



Top Speed Ordered In Work On Complex New Jet Units

A "crash" program — the aircraft industry terminology for maximum speed in production — has been under way for several weeks in Ryan's jet engine building on development of highly complex, infinitely precise parts on new projects.

It has meant working around the clock, with some machines never stopping as one 12-hour shift gives way to another 12-hour shift. Some men have been working 12 to 14 hours a day, 7 days a week, because of the urgency of the assignments given Ryan by such major jet engine manufacturers as General Electric, Wright, Pratt & Whitney Aircraft and Ford.

Affected have been crews from production engineering, tooling inspection and production. A recent example of the extraordinary burden of work placed on this group entrusted with new development was a 27-hour stretch, with time out only for meals, during which ten men rushed to completion a General Electric unit required at a certain time. The men stayed on the job from 5:30 one morning to 8:30 the next morning.

On one of the units for the advanced Wright engine, in which new welding techniques are being developed, first shift welders continued beyond their ordinary 4 p.m. quitting time until 2:30 the next morning on one occasion.

The "crash program" is for the purpose of producing the first units, ironing out the inevitable difficulties of a new project, and steering the work into quantity production. Recently 20 separate development jobs for the various engine manufacturers were assigned for rapid completion; hence the extremely long hours for the specialized crews.

These tests required that the tank be rocked back and forth through a 30-degree angle from 10 to 16 times a minute for 25 hours. At the same time the structure was vibrated at a frequency of 90 percent of the normal rated crankshaft speed of the KC-97's power plants. Then, the tank was sloshed alone for an additional 15 hours.

Temperature tests require that the tank be subjected to 160°F. for seven days and —65°F. for three days while filled with liquid containing a staining agent. Any leakage exhibited by the test or structural failure caused by the slosh and vibration tests will disqualify the design.

Although the tanks are not intended to be dropped in normal use, they are jettisonable for emergency conditions. This is accomplished by attaching them to the underside of the wings with standard bomb attachment fittings. A solenoid switch, actuated by the pilot, cuts the tanks free, like a released bomb. Quick-disconnect fittings for fuel and electrical lines insures their clean break-a-way.

The only accessories within the tank are tandem-mounted, twin electric motor-driven pumps which force the fuel into the aircraft's main fuel system. These units are located in a cavity in the tank bottom and are readily accessible for replacement or repair through a removable access plate.

Civil Air Patrol To Use Navion L-17 Planes

A new role for the Ryan Navion L-17 military liaison plane has been disclosed with announcement by the Army and Air Force that 170 of the planes will be made available to the Civil Air Patrol for the performance of its assigned missions.

According to Maj. Gen. Lucas V. Beau, USAF, National Commander of the Civil Air Patrol, the Navions will augment the fleet of military planes presently "on loan" to the Civil Air Patrol for air search and rescue, air support of Civil Defense, disaster relief, mercy missions and familiarization and orientation flights for young men enrolled in the Civil Air Patrol Cadet program—a nation-wide aviation education program for youth.

The loan of military Navions to the Civil Air Patrol recalls World War II use of civilian planes when Ryan S-C metal cabin planes were among aircraft flown by personal plane owners in providing off-shore anti-submarine patrol for the Army Air Forces.

Many of the L-17 Navions to be used by the Civil Air Patrol are being returned from Korea where they did yeoman service, particularly during the early phase of the war, in providing aerial observation, artillery spotting, bird-dogging targets for jet fighter planes and providing front line transportation for field commanders including those of General rank. Other L-17s will come from the National Guard.

The first planes are expected to be turned over to the CAP units sometime after July 1 and the project of incorporating the Navions into the Civil Air Patrol activities should be completed by the end of December next year. Gen. Beau hailed the acquisition of the L-17's as a "big step" in increasing CAP's effectiveness as an aerial search arm of the Air Force's Air Rescue Service.

Last year CAP's volunteer crews flew more than 12,200 actual search hours on missions directed by the Air Rescue Service. This amounted to more than 60 percent of the total hours flown by all agencies participating in these missions. CAP members receive no pay, per diem or allowances on these missions. They are, however, reimbursed for the gasoline and oil actually expended in their planes during the missions.

THIN-WALL DUCTING

(Continued from Page 3)

the overall weight saving realized. This is highlighted in the example of how air can be used to start the airplane's engines. Engine starting is a problem which grows in proportion to the increased size of large jet engines. These power plants require high, sustained expenditures of energy in order to bring their rotational masses up to starting r.p.m.

If starting equipment is carried internally in the aircraft it imposes substantial weight penalties. By using air turbines, geared to the turbojet's main shaft, it is possible to start these engines with light weight equipment. Through the use of air duct connections between engines, one power plant can be used to start all of the others in the same airplane.

Ryan is devoting extensive laboratory and production facilities to the development of the thin wall ducting systems which deliver hot, compressed air to strategic points throughout modern aircraft. This is highly specialized work in an unexplored field which should not be confused with ordinary ducting. Experience gained in fabricating ordinary ducting is helpful but not sufficient.

Thin wall ducting must handle high temperature air under high pressures with velocities running to the speed of sound. Often designs must be capable of withstanding bursting pressures of from three to four times operating pressures. Temperature changes are so wide that extensive thermal expansion must be accommodated. Strength requirements are high and gas-tight integrity is the aim. Systems must be flexible for installation purposes and resistant to corrosion and oxidation under all conditions of high and low temperatures. Because temperatures, pressures and velocities vary, it is mandatory that some custom design be accomplished in the development of each aircraft system.

The over-riding requirement which complicates all phases of the work is the extremely light gauges used, dictated by weight-saving demands. Wall thicknesses run from .008" to .020" with duct diameters ranging from 1.5 to 7 inches. These gauge limits impose exceptional problems on all production processes.

Tubing can be obtained either by welding rolled sections or using seamless tubing. Lengths are limited to relatively short runs in order to provide greater flexibility for installation and replacement purposes. The sections are fitted together with especially designed elbows, T-joints, Y-connections and other fittings which are precision-built to meet the stringent requirements.

Fusion and resistance welding and brazing are methods used to join duct components. Ryan has long specialized in all of these methods and has developed new techniques for their use with thin wall ducting. Thin wall thicknesses present added welding problems. For instance, in butt welding sections together a slight misalignment of only .005" may render parts which are only .016" thick unfit for service where it would not be a cause for rejection with exhaust system ducts which are .050" thick.

Another cause for concern is the welding of very thin sections to heavier gauge fittings. Ryan welds ¼" flanges to tubing that is .020" thick with special jigs and fixtures to prevent distortion. With such differences in thickness, the welding heat is dissipated at widely varying rates in the two components, tending to cause uneven heating and severe distortion.

For the higher temperature systems, Ryan prefers to use resistance and fusion welding for joining the components, rather than brazing. Silver brazing alloys do not possess sufficient strength characteristics at 750° F. to handle compressed air under a typical condition of 250 p. s. i. A number of other brazing alloys, such as copper types, do have high strength properties at elevated temperatures but require high temperatures for brazing.

Copper brazing demands a temperature of 2050° F. This is exceedingly high for production of thin wall structures. If

(Continued on Next Page)

the parts are brazed in a furnace, the holding fixtures are subjected to a withering blast of heat which renders them useless. If they are induction brazed, heating is so rapid and temperatures so near the critical temperature of the parent metals that it is difficult to prevent distortion and deterioration.

Welding techniques produce sound joints which meet every demand of service. Inert gas-shielded arc welding is a favorite at Ryan for this work because it involves localized application of heat which can be controlled. Low electrical currents are employed due to the thinness of the metal. This results in very short arcs which are often hard to see. Prerequisites of good welding results are careful edge preparation and close fit-up because the molten weld puddle is very small and slight burrs on the parts can cause a break in surface tension which will permit burn-through.

Thin wall ducting systems must have good flexibility and range of movement to accommodate thermal expansion and allow for movement of airframe structures. This is achieved by the use of a variety of devices such as movable joints, bellows and expansion bends.

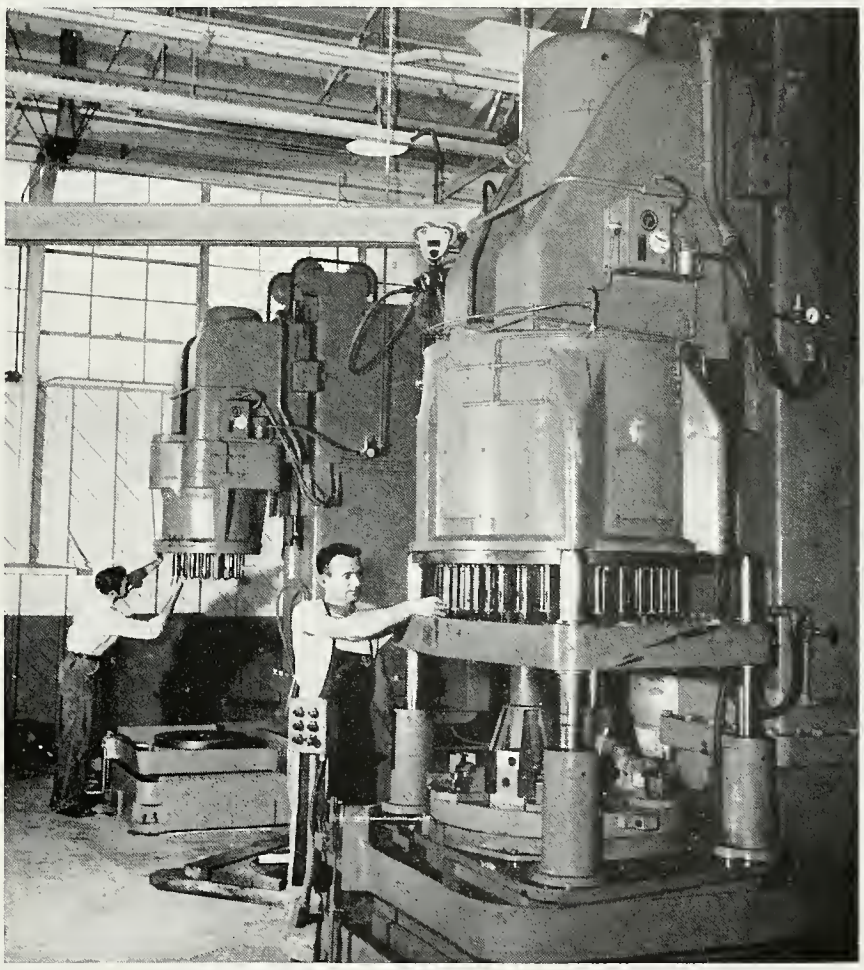
At first glance, bellows-type joints would appear to answer the need because they are a gas-tight device of good flexibility. While bellows are suitable for some installations, Ryan engineers have found them to inadequate for high-pressure, high velocity systems. Under high pressure they tend to straighten out and must be anchored against this contingency. This reduces their flexibility. When used with high velocity air streams, bellows corrugations cause severe turbulence and with sonic speed air they cause shock waves which shorten life of the duct system.

U-type expansion bends and loops are useful in providing a means for meeting thermal expansion movement but these stratagems do not provide anything approaching adequate flexibility and they tend to straighten out under pressure. They also cause drag and high friction losses which decrease the energy available from the air flow.

Ryan has adapted ball-and-socket joints, an exclusive Ryan development, and slip-type joints to thin wall ducting. The ball-and-socket type provides for universal action while the slip-joint permits lineal movement required to meet thermal expansion demands. Combinations of the two types are used where all conditions must be handled.

In addition to joints based on standard configurations, Ryan engineers have created new designs which are tailored to handle thin wall ducting needs. These light-weight sheet metal and machined components have performed well under the most rigorous test conditions.

Because high strength and corrosion resistance are indispensable properties of thin wall ducting materials, stainless steels are used. However, Ryan is pursuing the possibility of employing other metals such as Titanium, Inconel X, and Armco 17-7PH in these applications. Ryan is developing new methods for fabricating Titanium under both Air Force and Navy contracts and this knowledge is available to the thin wall ducting program. Ryan has also gleaned valuable experience in handling Titanium through the production of thin wall cooling shrouds made from this material for helicopter engines.



Massive Drilling Machines Arrive

Two huge multi-spindle drills have been installed in the jet building, and the last of seven giant King vertical turret lathes, with 42-inch bed diameter, has arrived in the plant.

These tools will make the machine shops in the jet building and the main factory building among the best equipped of their kind in the west.

Within a short period of each other, after a long waiting period, the two drills, one with 40 spindles, the other with 60 spindles, were shipped to Ryan from the Michigan Drill Head Co., of Detroit. Their total value exceeds $80,000.

Use of these machines, capable of drilling numerous holes simultaneously, will step up production of component parts for the J-57 jet engine. Ryan now has three such drills, the first one, a 40-spindle Natco, built by the National Tool Co., of Richmond, Ind., delivered here early last year, for use in the aft end of the General Electric J-47 jet engine aft frames.

The seven King lathes received by Ryan this year are part of the $1,000,000 aggregation of new large tools with which the plant is being equipped to accelerate output and increase efficiency. One "nest" of high powered lathes in the factory is worth $450,000.

FORD BUILDS J-57's

(Continued from Page 7)

in March, 1952. A steady stream of Wasp Majors continued to pour from Ford to power Convair B-36 Intercontinental Bombers, Douglas C-124 Globemaster cargo carriers and Boeing KC-97 Stratofreighter aerial tankers.

Ryan built the large stainless steel exhaust systems which were fitted to these big engines at Ford. These thin walled structures were precision-formed and welded to mate with the close tolerances of the power plant. They channelled the flaming exhaust gases from the power plant's 28 cylinders and ducted them to tail-pipes and turbosuperchargers. Ryan is currently building similar exhaust equipment, based on an ingenious Pratt and Whitney Aircraft design, for the Wasp Majors which that company is producing.

When U. S. defense plans indicated that the J-57 was to be required in stepped up volume, Ford was a natural facility to provide this production under prime contract with the government. The first Ford-built J-57 was shipped to the Air Force in April of this year—two months ahead of the tight schedule established. Today, Ford is well on its production way.

Engine sections are built up at Ford on a novel elevator-type platform which is lowered into a well as the structures are assembled. This permits the easy assembly of attenuated sections in the minimum of floor space and with full access. Another advantage is the elimination of even slight sag, due to weight of the outstretched components, which would tend to place uneven stress upon attaching flanges.

To test J-57's, Ford built six modern test cells which are rated by the Air Force as the quietest and most efficient in the world. This facility contains more than 100,000 square feet and is constructed from double walls of reinforced concrete running as high as four feet thick.

Extensive research with scale models of the $4 million facility was pursued to insure that the high soundproofing requirements would be met. The result is so satisfactory that conversation can be carried on in a normal tone of voice in the immediate test cell area even when an engine is operating on full power test. Without this protection, such conversation would not be possible within a mile of a J-57 under test.

Engineers state that the new cells have reduced the noise levels to one one-hundredth of what they would ordinarily be. This means that a jet engine and afterburner, operating at full power, would produce the same amount of noise at 300 feet from the test cells as an unprotected power plant at six miles distance.

With outstanding facilities such as these and unmatched mass production know-how, Ford's Aircraft Engine Division is confident that it will continue to be a major contributor to the nation's aircraft power plant needs.

THE CONTINENTAL WAY

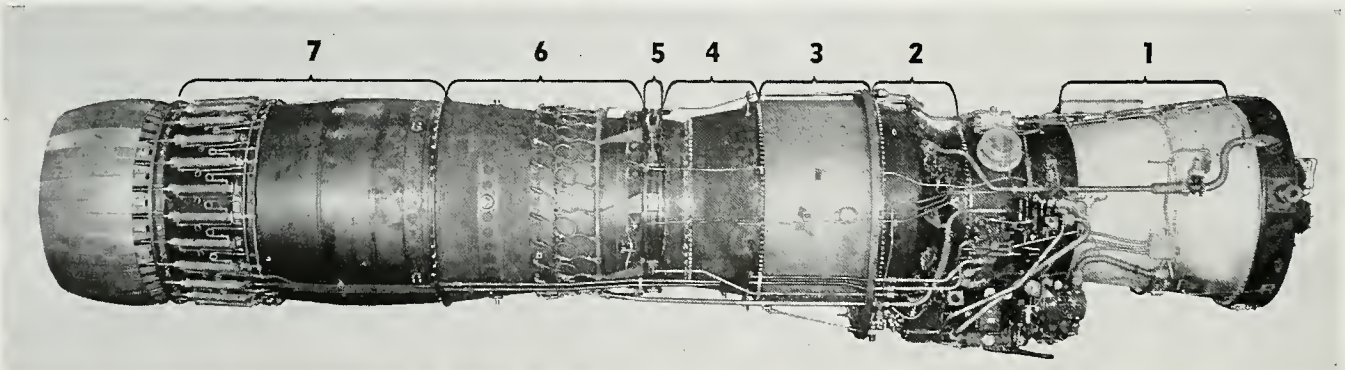
(Continued from Page 13)

J-69 has valuable utility as an auxiliary power source for transports. When added to a Flying Tiger twin-engine transport, the turbojet improves takeoff performance, especially under full load conditions, at both high and low altitude airports, and in hot weather takeoff when the thinner air provides less wing lift.

At present, the demand for the Continental Marbore is greatest for the Ryan Firebee pilotless jet plane, which has performed some of the most successful drone tests in this country with this engine. Production of Firebees is underway at the Ryan plant for the Air Force, Army and Navy.

The Continental J-69 engine is only 61½ inches long, including inner tailcone, and weighs only 300 pounds. Today's T-19 model, with 1000 pounds thrust, is the same basic engine which three years ago, as the T-3, produced only 880 pounds thrust. Both the increase in power and the improvement of altitude characteristics were achieved without any increase in overall engine dimensions or weight.

The partnership of French Turbomeca, Continental and Ryan has helped produce, in the Ryan Firebee, a remote controlled target plane that may have potentialities in the guided missile field, far beyond the scope of its original function as a high-speed target.



Ryan builds 30 different structures for the powerful new J-57 jet engine and afterburner. A good conception of the wide variety of these components can be gleaned from this side view of the big Pratt and Whitney Aircraft turbojet. Bracketed are seven large precision-made sheet metal assemblies and weldments which Ryan has fabricated. These are: (1) compressor cases, (2) diffuser section, (3) combustion chamber section, (4) turbine exhaust case, (5) engine mounting case, (6) front afterburner duct assembly and (7) rear afterburner duct assembly.

Other Ryan-made structures cannot be shown because interior views of the J-57 have not been released for publication. These include flameholder weldments, turbine nozzle assemblies, struts, combustion chamber weldments, ducts, cones, compressor weldments and many others.

Ryan builds some of these components for Pratt and Whitney Aircraft—designers of the potent J-57—and others for the Ford Motor Company—licensed to build J-57's as prime contractors to the Air Force.

DESTINATION UNKNOWN

(Continued from Page 1)

oid camera mounted in front of the Ryan computer-indicator instruments.

In the aft section, his right eye blackened by the rubber eyepiece of the drift sight, Warren V. Norris is perched over a drift meter. Periodically, he bends over the sight to squint at the ground below. Nearby, Paul O. Munchus monitors the "black boxes" that make up the bulk of the navigational equipment to see that everything is working properly.

At the drift sight, Norris sees what he is looking for, fumbles for the intercom mike on his lap and begins a "countdown."

"Ten seconds . . . nine . . . eight . . . seven . . . six . . . five . . . four . . . three . . . two . . . one . . . ZERO."

As the countdown reaches "zero," Norris presses a button near the drift meter. This triggers simultaneously all of the timing devices installed aboard the aircraft. The Polaroid camera in Bruce Clapp's compartment snaps a picture of the present readings on the navigational instruments; a large aerial camera mounted in the floor of the plane snaps a photograph of the check point Norris sees below; brush recorders indicate the pitch and roll of the aircraft. Up forward, Bruce Clapp hears the signal over the intercom, checks the time and marks the aircraft's position on the map.

This, then, is the data the engineers are seeking. The photographs, the recording paper, Bruce Clapp's maps and notes and the personal observations of all of the men aboard the aircraft will be analyzed on the ground following their return. The same procedure, repeated dozens of times over well-known check points along the course line, will provide the quantity of data required to statistically compute the navigational system's accuracy and reliability.

The flight test team has been conducting these tests on the Ryan navigational equipment for more than a year. This includes environmental tests over every type of terrain in virtually all kinds of weather. The equipment has met each new challenge successfully and is now in the advanced phases of the evaluation program.

Each flight is carefully planned in advance. Prior to scheduling the aircraft, Bruce Clapp confers with Carl H. Gottwald, engineer in charge of electronics systems development, and John J. Bowden, systems engineer, to determine the type of data required and the manner in which it can be obtained. Clapp then passes this information on to the crew of the P2V.

On this particular flight, the crew consists of Al Coha, R. "Dick" Yoder, co-pilot, and Curtis "Slim" Franklin, crew chief. Their recommendations, based on extensive flying experience, contribute to the planning of the flight.

The plane has been airborne for quite some time now. Bruce Clapp, who has been watching the mileage indicator on the navigational instrument display for the past few minutes, picks up the intercom mike and calls Warren Norris.

"What do you see through the drift sight, Warren?"

"We're right on the money, Bruce," answers Norris.

"Good! Now that we've arrived, shall I tell Al where we are, or just let him guess?"

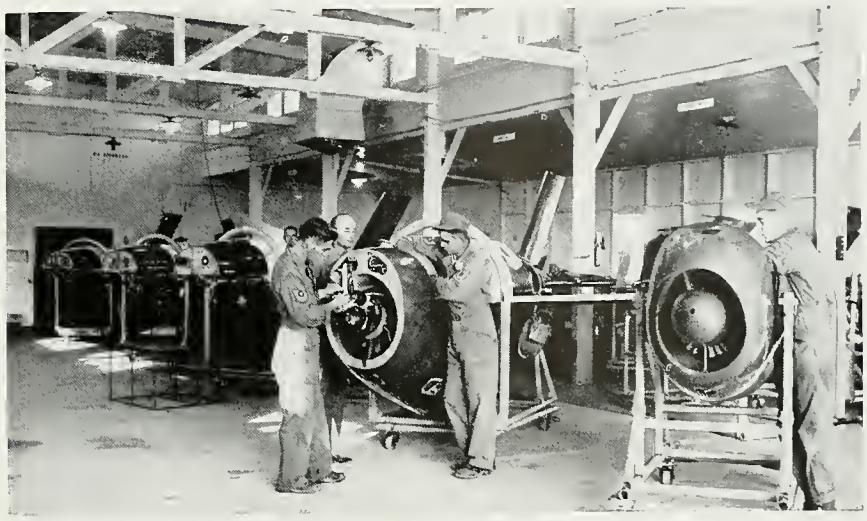
Norris laughs. "Let him figure it out. He usually guesses it before now."

"Right," Clapp answers. He calls Al Coha.

"Al, we're directly over our destination now. Take a look over the side and tell us what it is."

There is a pause as Al Coha banks the plane to get a better view of the ground beneath them.

"Well, whaddaya know."



Air Force Reveals Large New Firebee Order

A $3,500,000 production contract for an undisclosed quantity of Ryan Firebee pilotless jet target planes has been placed by the U. S. Air Force, T. Claude Ryan, company president, announced recently. It is the first Air Force production order since Ryan built a limited number of the Q-2 target drones for development and service tests by the Air Research and Development Command.

The new contract calls for production tooling, indicating that the program has reached the stage of expanded output. U. S. Navy and Army Ordnance orders are currently in production at Ryan.

Although officially classified as an aerial target drone for air-to-air, ground-to-air and ship-to-air gunnery training, the Firebee might well fit in the guided missile category. Its potential use as a guided missile was recently emphasized by Ryan in an interview featured as the "cover story" of American Aviation Magazine.

The Firebee project was started four years ago as a joint development of the Air Force, Army and Navy, and successful flight testing has been conducted at Holloman Air Development Center by the Air Force on behalf of all three services. Both ground and air launchings of these high-speed drones have been accomplished.

With the new Air Force order, Ryan now is producing Firebees for all three services, and the pilotless planes are being tested at Point Mugu, California, the Naval Air Missile Test Center, as well as at Holloman.

The Air Force Firebees will be equipped with the Continental J-69 jet engine, the American version of the French Turbomeca Marbore, which generates approximately 1,000 pounds thrust and is considered well suited for the requirement of the target drone. The Navy and Army Firebees use the Fairchild J-44 jet engine, which is a Navy-sponsored power plant. Most of the testing of the service quantity of Q-2s was done with the J-44 engine installed.

Walt Phillips, dispatching supervisor, left, and Darwin Whetstine, general foreman, machine shop, examine one of four large new dispatching control and load boards recently installed in machine shop. Eight more such boards have been ordered for other departments.

New System Shows Parts Progress

At a glance, Ryan dispatchers and other personnel now can tell the exact status of every job going through the machine shop in the main factory building.

A new type "Dispatching Control and Load Board" not only shows what work is on each machine at any particular moment, but what work is next in line and the jobs that are headed toward the machine shop from other departments.

The net result: better utilization of the mills, lathes, the drill presses, radial drills, and miscellaneous equipment. "Down time"—when a machine is idle—is minimized by coordinating all job preparation in advance. The new control and load board tells supervision when work is likely to run out for any particular machine. Planning of the work load can be performed more systematically.

In the past, tab was kept on the work in process through a daily visual follow-up. It was not possible for a dispatcher to know the specific machine that was to handle a specific job without checking with the foreman, assistant foreman or leadman.

The control and load board, in effect, pinpoints the exact progress being made of every job that must go through the machine shop.

TAMING TITANIUM

(Continued from Page 11)

phase of titanium behavior. The manufacturer who contemplates using titanium is faced with a time-consuming task of research and fact-gathering to assemble the practical information upon which to proceed.

Almost non-existent as a pure metal five years ago, titanium has enjoyed a spectacular growth. Inevitably, it will mushroom into impressive proportions in the aircraft industry because of the weight-saving advantages which it offers within certain temperature ranges.

Two factors inhibiting its wider use are its relatively high cost and the dearth of knowledge on how to adapt the white metal to present factory facilities. Undoubtedly, the dissemination of the Ryan report will stimulate greater use of titanium in industry. In turn, this will have a salutary effect upon costs because of the stepped up volumes of metal which the producers will be permitted to process.

The most important manufacturing processes covered in the complete Ryan report are forming and welding. Due to the space limitations necessarily imposed in this resume, only these techniques will be discussed at length with brief mention made of the other processes studied.

FORMING

Ryan conducted experiments in both hot and cold forming of commercially pure titanium. Drop hammers, punch presses, brake presses and power rolls were some of the forming tools used. A number of special arrangements were devised to heat the titanium sheets and dies by both mechanical and electrical means.

It was felt that the forming operations should embody sufficiently deep forming requirements to be representative of the most severe problems likely to be found in the aircraft industry. For the drop hammer work, blanks of 0.025" thickness, ranging in size from 12"x18" to 20"x30" were selected. These were formed into semi-circular cavities with irregular linear centerlines. Some of the stampings have multiple convolutions of both concave and convex proportions with respect to the die surface. The stampings were assembled into a section of an exhaust collector shroud for a helicopter engine.

Experience showed that parts, other than those embodying shallow draws, could not be cold formed in the drop hammer because the impact caused the parts to fracture in the stage dies after relatively small amounts of deformation. Use of various lubricants did not change this situation. Also, the complex allowances required to compensate for springback precludes the use of cold-forming for economic reasons.

Hot forming of titanium in the drop hammer was quite successful when a proper procedure was evolved. Initially, it was decided to use preheated sheets, brought to a temperature of between 900° and 1000°F. in a holding furnace and form them on heated steel staging and finisher dies. Mating punches of cast steel were used with two of the nine punches electrically heated — one with cartridge heaters and the other with Calrod units.

To heat the dies, a portable furnace was connected to a drop hammer of 3000-pound head capacity so that molten Hi-temp salt, consisting of sodium and potassium nitrates and sodium nitrate, could be circulated through the die. With a salt temperature of 1000°F., this arrangement produced a die surface temperature of between 575° and 700°F., depending upon the size of the die. The Calrod heated punch operated at 300°F.

First stamping operations began by treating the blanks as if they were stainless steel except for the fact that they were preheated. High temperature forming rubber was placed across the sheet in the flange area at the edges of the die and the full impact of the hammer was used. In every instance this resulted in fractures at or immediately below the radiused edge of the die.

Then, a procedure was developed in which the number and position of the rubber pads was varied and the blank was inched down with lighter blows of the hammer. Between each hit, the blank was

returned to the furnace and heated to the 900°-1000°F. range. In this way, the parts were successfully formed. Incidentally, use of dry lubricants, such as Ryan dry-lube or Everlube was valueless because of the high furnace heat which burned out the binder, removing the lubricant's adhesive quality. Petroleum base die lubricants could not be used because of the temperatures of the heated steel dies.

Although these arrangements were capable of forming satisfactory titanium parts on an experimental basis, Ryan does not consider them to be adequate for production purposes. A major objection to the use of heated dies proved to be the changes in die dimensions and configuration experienced. The design of the punch and die required that they be cleared for 0.025" material at room temperature. After heating, the blank material seized and galled in local areas because of lack of die clearance. In other areas, the correct contour was not realized because of excessive die clearance.

In order to clear the dies, they must be ground while at operating temperature and in the hammer. This is hazardous and time-consuming. Polishing the radii of the die tended to reduce galling of the material on the corners of the die but did not appreciably affect the tendency of the sheets to fracture due to seizing.

As the stamping experiments progressed, it became apparent that heated dies were not accomplishing the purpose of keeping the blank hot for forming. The temperature drop of the blank in still air is very rapid. When placed in the die, it is supported by the high points only, which does not provide sufficient heat transfer area to keep the part hot.

In view of these difficulties, it was decided to try the standard technique used to form stainless steel. This involves the use of Kirksite dies and lead punches. To avoid the possibility of lead contamination and prevent the heat from melting the lead, the punches were jacketed with mild steel on their contact faces. A generous coating of heavy weight commercial oil, SAE 250, was applied to the die to serve as a lubricant and heat insulator.

Using this arrangement, with the blanks furnace heated to 1000°F., the parts were repeatedly formed with satisfactory results. Temperature tests disclosed that the temperature of the blank, even when using cold tools, was higher than the hottest die temperatures recorded under the previous heated die method.

This work has shown conclusively that commercially pure titanium parts can be formed as satisfactorily as stainless steel counterparts without basic engineering design changes other than judicious selection of edge and corner radii at abrupt contour changes and liberal use of stage dies. It is primarily important to maintain blank temperatures above 700°F. for optimum forming characteristics. Heated dies are not of practical use while the use of cold Kirksite and lead tools offers an inexpensive, safe method for accomplishing the job.

By trial and error it was found that a single pad of forming rubber over the entire blank, with a build-up of smaller pads around the perimeter, gave the best results. As depth of draw increased, the amount of rubber used along the edges was reduced. As the rubber pattern used was worked out, the technique of inching the hammer down gave way to normal full-impact blows.

The oxides produced by heating, as well as the residual lubricants, were successfully removed by immersion in an 800°F. salt bath followed by a nitric-hydrofluoric rinse.

A number of flanged titanium parts were formed with trapped rubber contained in a heavy steel box attached to the head of a large Cecostamp air hammer. The blanks were heated to 1000°F. and estimated to be within 600° to 700°F. during forming. A pad of high temperature rubber was placed over the blank to protect the trapped rubber from the hot metal. Although the parts were successfully formed, the work showed that titanium exhibits strong resistance to the absorption of material in compression flanges.

Ryan also was successful in heating the titanium blanks to the 900°-1000°F. range electrically by attaching electrodes to the sheets and passing current through them. This is a practical method which has the advantage that the heating can be done while the rubber pads are being placed, saving some heat loss incurred when the furnace method is used.

Forming was performed on punch presses capable of exerting 105 tons. Best results were obtained in the forming of

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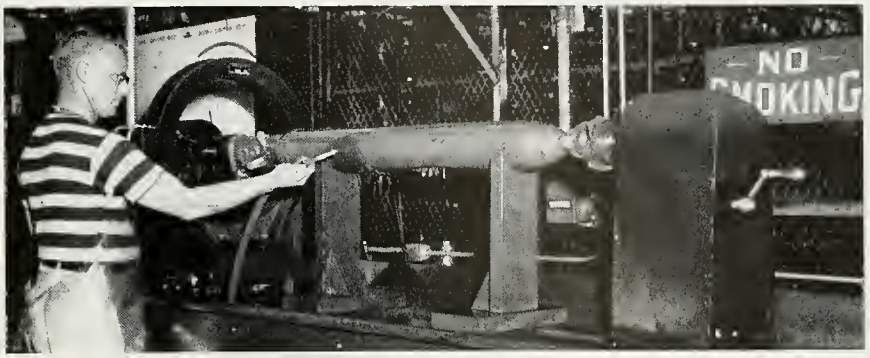

Magnetism Employed In Inspection Technique

The largest Magnaflux magnetic particle inspection machine now in service in the Ryan plant is shown in the machine shop inspection crib. The recently installed machine has a 96-inch maximum clearance between the electric contact plates. Nello Giddens, Magnaflux inspector, is shown applying iron oxide in an oil solution to a part which is charged with a high amperage current. The iron oxide is drawn into any defects in the metal, leaving a telltale red line. A still larger inspection machine, with 138-inch clearance, and capable of handling bulkier parts, is due for installation here soon. Internal, as well as external cracks, can be discovered with the use of this type of equipment.

Ryan Program Studied

Ryan's work simplification program, gaining wide recognition in industrial circles, was studied recently by four top officials of the Food Machinery and Chemical Corp., Riverside, producers of armored personnel carriers using Ryan exhaust equipment. Left to right, observing Bob Pickens, manifold assembler in Department 151, are Charles O. Dalton, production manager, commercial; George Bartlett, production manager, defense; Ken Dawson, work manager; and Jack Dunbar, industrial relations manager, of Food Machinery.

0.025″ sheet titanium by using blanks heated to 900°F. in a furnace. The die was heated to 275°F. with electrical heaters and insulated from the punch press by sheet asbestos.

Cold forming on the punch press requires greater attention to contour forming of the blanks to permit the metal to flow to the proper die contour. As temperatures drop toward room temperature, the use of lubricants becomes increasingly important. The most successful room temperature forming was accomplished with copper plated blanks which were dipped in a forming lubricant or by using blanks coated with a film of colloidal graphite. The colloidal graphite is simpler to apply and less expensive.

On a 250-ton hydropress, blanks that were 10¼″ in diameter were cold formed into hat-sections 3½″ deep. The machine was operated at the lowest speed—about one inch per second—to allow the material the maximum recovery time during forming. Ryan Dry-lube was used as a lubricant. The parts were drawn in four successive draws without removing them from the die.

Strips of titanium in several thicknesses, 0.018″, 0.040″, 0.080″ and 0.125″, were bent in a brake press using dies of decreasing radii, until a fracture occurred to establish minimum bend radii for design purposes. Specimens were bent with their edges either in the sheared, milled or polished condition. Edge preparation seemed to have no effect on results of the bend tests.

The 0.018″ material took a 1.7T bend without fracturing. Bends in the transverse and longitudinal directions gave the same results. Minimum bend radii for the 0.040″ material fell over a wide range; longitudinal samples 1.66T to 2.35T, transverse samples 1.95T to 3.90T. Minimum bend radii for 0.080″ sheet covered: longitudinal samples 1.95T to 2.35T, transverse samples 1.70T to 2.54T. For the 0.125″, Material, longitudinal samples ranged from 1.50T to 2.12T and transverse samples 2.12T.

FUSION WELDING

Experience in the Ryan study showed that inert gas shielded welding is the only type of fusion welding that can be made on titanium if it is desired to maintain adequate physical properties. This is because molten titanium will react with, and be embrittled by, all known welding fluxes as well as air. Ryan welded a substantial number of specimens with both manual and automatic inert gas shielded methods. Butt welds were successfully made in an automatic heliarc machine using ⅛″ diameter thoriated tungsten electrodes and a 5/32″ electrode distance. A copper tube with a ⅜″ flare outlet was used to follow up the weld and blanket the hot metal with argon gas to prevent contamination during cooling. On the underside of the weld a grooved back-up bar was used which blanketed the underside with argon gas. This arrangement consumed 7 cubic feet of argon gas per hour for back-up needs and 20 cubic feet per hour at the electrode.

Welds were made at the speed of 27 inches a minute with 65 amperes of current. Results of this work disclosed a number of factors important to good fusion welding of titanium. Many of these are not peculiar to titanium but are also encountered in the welding of stainless steels and other alloys.

Shear-cuts must be straight and smooth and fit must be close, running to within 0.001″ on 0.016″ material. Poor fit will cause burn-through on light gauges. Best back-up is a flat copper bar. On light gauges, no gas back-up is necessary if the material is tightly pressed against the copper back-up bar.

In heavy gauges, an excessive gap will give a concave bead surface. A slow welding speed will cause a wide bead. Amperage has less effect upon penetration than welding speed. As gauges run higher, amperage input goes up, disproportionately.

Welds of good quality, in which the welds were found to be stronger than the parent metal, were obtained. This was revealed in tensile tests in which fractures occurred outside the weld zone. The major yield was confined to one side of the weld. Failures that occurred in the weld zone initiated in small flaws within the bead. Bend tests indicated that the gas shielding provided good protection and that most welds exhibited good ductility. The welds took a 180° bend in both longitudinal and transverse directions without failing.

Ryan performed Sigma welding using 0.125″ sheet and 0.64″ titanium wire. Circular passes were made on one side of each sheet. The welds were found to be very sound in structure with penetrations of between 20% and 40%.

A 180° bend was obtained when the bend placed the bead in compression. A bend, placing the bead in tension, fractured at 45°. This fracture started at the surface of the bead. Microscopic examination of the original cracks showed them to be approximately 0.007″ deep. This indicates that the weld bead may have a contaminated surface skin which is very hard. Such a surface would shatter under tension and create stress concentrations which would lead to failure. All discoloration of the welding was removed by processing in a salt bath at 800°F. for 10 minutes, followed by 20 minutes immersion in a pickling solution.

Following successful butt welding of titanium by automatic heliarc welding, a number of lap welds were made. Welds were accomplished in 0.016″, 0.063″ and 0.080″ materials. They were made with manual Heliarc torches equipped with a follow up tube of argon gas flow. Hand-fed commercially-pure titanium wire was added as filler rod.

Static tensile test failures occurred either in the parent metal or the weld heat-affected zone. The welds were sectioned and examined for penetration and structure. Results showed that good care is required to maintain proper root penetration.

An additional departure from the handling of stainless steel alloys was noted. When shearing stainless steels in preparation for rolling and welding a cylindrical body, allowances are made for anticipated shrinkage in the longitudinal butt weld. The welded parts are then sized on expanding mandrels. With titanium, no shrinkage in the welded cylinder occurs and it is often necessary to shrink the welded part to mate it with others.

(Continued on Next Page)

Sales Executive Joins Ryan As Staff Assistant

Frank J. "Pat" Morgan, former Air Force officer, this month joined the Ryan organization as staff assistant to Sam C. Breder, customer service director. He is in the midst of a 14 weeks' indoctrination program to familiarize himself with all departments in the plant.

F. J. Morgan

During World War II, Morgan attained the rank of lieutenant colonel in charge of personnel and office management of the Air Service Command's maintenance division at Wright Field.

Prior to his military duty, Morgan for 12 years was sales representative for Butler Manufacturing Co., Kansas City, a widely known metal products firm. After World War II, he came to La Jolla, and entered into a partnership which acquired the Morgan-Thornton Department Store. He sold his interest last April.

RESISTANCE WELDING

A wide variety of combinations of sheet thicknesses were tested on spotwelding machines to determine the conditions favorable for spotwelding titanium. Extreme thick to thin ratios were spotwelded without difficulty. Gauges running from 0.025″ to 0.125″ were handled. An intensive investigation of electrodes, pressures and currents was pursued. Results showed that lower electrode pressures (800 to 2000 pounds) produced a coarse-grained nugget. Increasing the pressure resulted in a finer-grained structure. The transition point seemed to come at about 2000 pounds.

At lower electrode pressures, penetration is heavy. One sample average 75% with some cast weld stringers extending approximately 95% into the parent metal, with an 800 pound pressure. Nugget grains were very large. At 3000 pounds of pressure, penetration was 50% maximum and 10% minimum and there was a marked refinement in grain structure.

During tension and shear tests, it was noted that in several cases yield points occurred at 250 to 800 pounds. After yielding, the specimens recovered and continued to failure. This was caused by the failure of the corona bond.

A typical series of shear tests, showed values from 2100 to 2346 pounds, with a deviation of 10.6%. In general, Ryan's examinations showed that good spot welding of titanium may be achieved with proper precleaning, relatively high electrode pressures and a short weld time. Complete certifications for a variety of gage combinations were developed.

Tests were made to determine the effect of various types of electrodes. These were conducted with Class I, II, III and XI electrodes having ⅜″ faces and 3″ radii. Results showed that the Class II and III electrodes produced the most satisfactory welds. Penetrations ran from 40 to 45% with nugget diameters of 0.145″ and 0.150″. The dendrites found in these samples were finer and more uniform than those produced by the other classes.

Ryan investigated the seam welding of titanium sheet in gauges of 0.016″, 0.025″, 0.040″, 0.080″ and 0.125″. In general, the welding characteristics were not different from those experienced with spot welding. Complete machine settings and charts were developed to guide others.

It was found that pressure and heat should be maintained on the minimum side to prevent excessive indentation and expulsion, respectively. Speeds in the range of 15 to 20 inches per minute were found to be satisfactory. Hold times, weld times, cool time, etc., were somewhat similar to the values used with stainless steels.

Special care must be exercised to maintain penetration at a low value or it will approach 90%. Small changes in machine settings will cause large increases in penetration. The standard peel test affords a quick method of determining approximate penetration. It is not as satisfactory on titanium as on stainless steel due to the brittle nature of the heat-affected zone.

Indentation is greater with titanium than with the seamwelding of most materials. A difficult problem presents itself if low indentation values are required. Surface discoloration was slight on thinner gauges, becoming quite heavy on the thicker material.

EMBRITTLEMENT

Ryan tested the embrittlement of titanium samples by exposing them to a synthetic exhaust gas atmosphere. The specimens were sealed in a heat-resistant alloy cabinet which was purged with the gas mixture (85% N_2, 11.5% CO_2 and 3.5% O_2) at the rate of 12 liters per hour. Tests were conducted at uniform temperatures between 1000° and 1400°F.

Times of exposure varied from between 4 hours and 350 hours. Samples were suspended so that no gas impinged directly upon the parts. Results were evaluated by bend tests. Tests showed that very little embrittlement occurred at 1000°F. but that the rate increased rapidly as the temperature approached 1400°F. Rockwell "A" hardness readings failed to show a marked increase in the hardness level, even after exposures at 1400°F. where embrittlement was the most severe. At 1400°F., a marked change in the adherence of oxide scale was noted. Heating to, or cooling from, this temperature caused the scale to spall off in large flakes.

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ON THE COVER

Ryan crew of a Navy P2V "flying laboratory" look over the route they have flown on test mission described in the story on Page 1. Looking at chart are crew chief Curtis Franklin and engineering pilots, Al Caha and Dick Yader.

RIVETING AND DIMPLING

First experiments with cold riveting were not successful. Using ⅛″ diameter rivets and hole diameters of 0.128″, the rivets did not swell or spread to fit the holes, when standard riveting guns and bucking bars were employed. These were button head rivets. With flush rivets and pressures of 0 to 5000 pounds, exerted over one second, the results were good.

Similarly excellent results were obtained with ⅛″ button head rivets which had been annealed for 20 minutes at 1300°F. and driven with a force of 5100 pounds. Good results were achieved in the experiments with hot riveting in which ⅛″ rivets were inserted in drilled sheets of 0.072″ and 0.018″ material and placed in a Federal spot welder. The machine was equipped with Elkalloy-A electrodes with ⅛″ spherical radius counter-bored faces.

Hot dimpling was performed on both stationary and portable squeezers. Dies were heated with resistance type elements. Dimples were formed in 0.016″, 0.025″, 0.040″, 0.063″ and .080″ for a variety of rivet and screw applications running from 3/32″ to ¼″ diameters. Results indicated that dimpling of titanium offers no greater problem than does 75ST aluminum with the exception of increased forming temperatures.

Forming temperatures should be within 600° to 700°F. to produce structurally sound dimples, free from critical fracture strains. Satisfactory dimples can be made at lower temperatures but inconsistencies in sheet stock preclude its recommendation.

Ryan conducted a thorough study of other manufacturing processes involved in the fabrication of sheet metal titanium parts, such as drilling, grinding, sawing, blanking, cleaning and deburring, but space limitations do not permit their description in this resume.

PROVING GROUND OF THE FUTURE

(Continued from Page 19)

tube could bring about the loss of an entire missile.

Responsibility for the test and evaluation of guided missiles and their components is that of NAMTC's Test and Evaluation Facility, which is composed of five technical departments. These departments—Missile Test, Component Test, Range Instrumentation, Technical Information and Technical Service—are staffed with both military and civilian engineers and technicians. All of the departments are directly involved in, and responsible for, the testing activities of the Center.

Actual flight testing of guided missiles and pilotless target aircraft—such as Ryan's KDA-1 Firebee—is conducted by one or another of the three missile divisions of the Missile Test Department. The Firebee flight test program, to cite an example, is under the cognizance of Missile Division III, commanded by Cdr. R. M. Hayler. The NAMTC project officer on the Firebee program is Lt. George Miller.

The Firebee flight test program at NAMTC is currently in what is known as a "Phase A" Program. This consists of a joint Navy-Ryan evaluation of the Firebee's remote control equipment, performance characteristics, flotation capabilities and over-all suitability for Navy use as a target drone. A group of Ryan engineering personnel is assigned to Missile Division III to assist the Navy in this evaluation. A number of the high-speed pilotless jet target drones have been successfully air-launched and recovered from the sea off Point Mugu.

NAMTC's nerve center insofar as missile operations are concerned is the Flight Test Control area. Here can be found the instruments used for the final checkout of the missile on the launching platform; firing sequence timers; instruments that record the data pouring in from tracking stations; computers and analyzers used in reducing the mass of data down to the exact performance characteristics desired; and special destructor controls to blow the missile to pieces in case it edges outside the limits of the range.

In a specially designed room at Point Mugu, a huge $3,000,000 electronic marvel that can perform approximately six million mathematical operations in five minutes running time is used by NAMTC personnel to work out equations and problems that would take an average mathematician at least four years to complete. Developed by the Raytheon Corporation of Waltham, Mass., the device checks itself ten times for accuracy before producing an answer.

Largely due to its unique mission, NAMTC is an unusual military installation in that the proportion of civilian personnel to military is so high. Specialists for the most part, this closely-knit team bears the primary responsibility for the success or failure of the Center's test work.

In view of the growing significance of the guided missile as a prime factor in national defense, the work of NAMTC's scientists and engineers is of vital importance to the present and future security of the United States. It is to these men and their colleagues at Air Force and Army missile test centers that the missile designers and the production men of the future must look for ultimate guidance.

A mockup board from Wright Air Development Center recently visited the plant to examine the mockup of a new plane developed by Ryan. They are shown with Ryan officials in a restricted area of the plant.

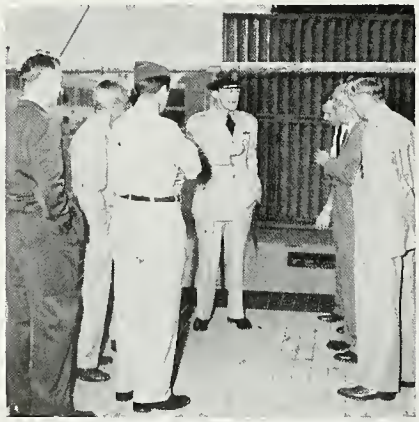
Top Air Force Visitors at Ryan

Major General Albert Boyd, one of the nation's leading test pilots who is now commander of the huge Wright Air Development Center at Dayton, Ohio, visited the plant recently to inspect an advanced new research project which Ryan is developing for the Air Force.

Boyd's command is the Air Research and Development Command's largest research center from the standpoint of personnel and equipment. Its $200-million concentration of aeronautical research and testing equipment is devoted to the building of progressively better new air weapons for the Air Force.

One of the first USAF pilots to fly faster than sound in the Bell X-1, General Boyd has flown virtually every U. S. military aircraft and many of those of friendly foreign governments. Prior to his assignment to WADC, he was commander of the Air Force Flight Test Center at Edwards, Calif.

Boyd's visit followed that of an Air Force mockup board, also from WADC. Composed of Air Force and civilian engineers, the board visited the plant to examine the mockup of a new plane developed by Ryan.



Maj. Gen. Albert Boyd, commander, Wright Air Development Center, is pictured conferring with Ryan officials while inspecting advanced new Air Force project here. Left to right, John Herald, Ryan weapons system engineer; Bruce Smith, director of engineering; Capt. E. W. Locke, Boyd's aide; Gen. Boyd; Pete Girard, project pilot; T. Claude Ryan, president; and H. L. Braasch, chief of the aircraft section, engineering.

Is the Constitution Old-fashioned?

IT IS common practice today in some circles to look upon the Constitution of the United States as an old-fashioned, cumbersome instrument that frequently gets in the way of modern, streamlined social-economic "inventions" that could cure all of our ills were they not "unconstitutional."

So, it's pertinent to ask if this document by which we live still has real meaning and importance to the American people.

This particular article concerns the Sixth Amendment, which begins with these words: *"In all criminal prosecutions the accused shall enjoy the right to a speedy and public trial."*

You might easily get the impression that this is an unimportant right because this crude violation of basic human rights just couldn't happen in this day and age.

But the fact remains that in this day and age *most of the people alive still can be thrown into jail and held without trial.*

The wise men who wrote our Constitution had a great knowledge of the history of government and a great knowledge of the dangers to freedom always present in government-by-executive-decision rather than government-by-written-law.

In writing down the conditions of their freedom, they took no chances: they "dotted every i and crossed every t."

They believed that even the most honest, public spirited, and virtuous administration should be hedged around with restrictive provisions that would prevent the possibility that rule-by-man might supplant rule-by-law.

Those who say that our Constitution is a handicap to the prompt and efficient solution of national problems are correct.

In fact, the Constitution was deliberately written so that it would be a "drag" on quick decisions because its authors well knew that most of the governmental mistakes recorded in history happened as a result of "snap judgment."

They thought that *temporary* inconvenience and suffering are to be preferred to *permanent* loss of liberty.

They thought that the "blood, sweat, and tears" involved in regaining liberty is immeasurably greater than the occasional suffering that inevitably arises in the exercise of liberty.

But those who say that our Constitution is "old-fashioned" are either ignorant or deceitful, because it is the newest, youngest, most modern device to solve the oldest, meanest, and most persistent problem of mankind: *how to have a government strong enough to protect the people's freedom without being strong enough to destroy the people's freedom.*

It is not perfect, but it is *closer to being perfect* than any other framework of government.

Reprinted courtesy of The American Economic Foundation

RYAN AERONAUTICAL COMPANY
P. O. BOX 311
SAN DIEGO 12, CALIFORNIA

RYAN
RANGE EXTENDERS ADD COMBAT MILES

World's largest—Ryan fuel tanks for B-47 Strato-jet

THE PROBLEM: The world's fastest bomber, the far-ranging B-47 Strato-jet, needed the world's largest wing fuel tanks . . . tanks with a capacity equal to that of a good-sized tank truck. What's more, these tanks had to be completely gas-tight by welding alone. THE SOLUTION: Boeing turned to Ryan who devised ingenious methods to manufacture in volume the huge, external tanks —each of which requires more than 30,000 electrical spot welds.

Besides developing and manufacturing products of its own design, Ryan produces airframe components to prime contractors' specifications. Typical of these are other "range extending" products, like the Ryan-built aft fuselages and refueling pods for Boeing's KC-97 mid-air refueling plane.

These accomplishments point up Ryan engineering skill . . . skill that has been *specialized, ingenious* and *versatile* for 31 of the 50 years since powered flight began. Master craftsmen, Ryan does the *difficult*, the *intricate*, the *precision* jobs of today's high-speed air age.

RYAN AERONAUTICAL COMPANY

Factory and Home Offices: Lindbergh Field, San Diego 12, California
Other Offices: Washington, D.C.; Daytan, Ohio; Seattle, Washington; New York City

Ryan builds Boeing KC-97 fuel tanks, too.

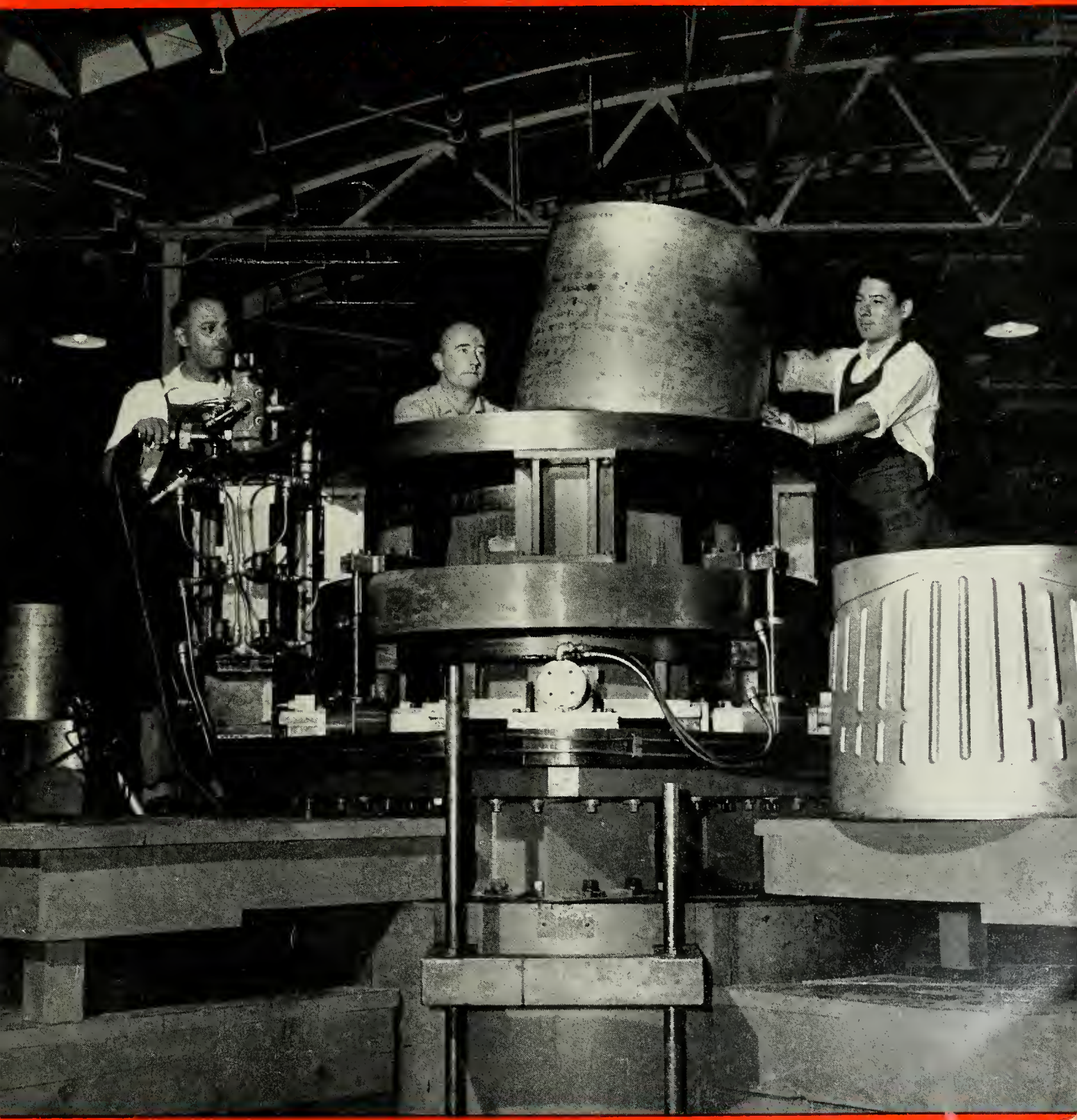
RYAN

★ SPECIALIZED
★ INGENIOUS
★ VERSATILE

Advanced-type Aircraft and Components
Jet and Rocket Engines and Components
Exhaust Systems for Aircraft
Electronics Equipment
Ceramics for "Hot Parts"
Weapons Systems Design and Management
Aircraft and Power Plant Research
Metallurgical Engineering
Thin-Wall Ducting
Firebee Pilotless Jet Planes

Pioneers in Each ★ Leaders in All

Ryan REPORTER



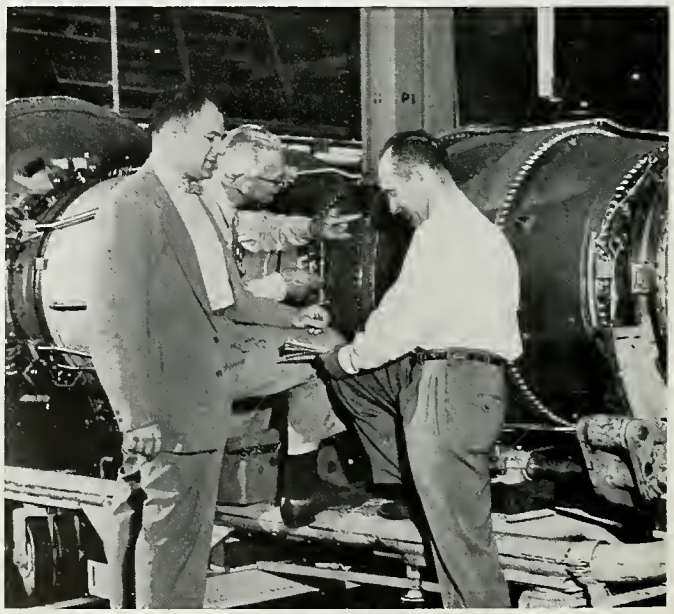
VOL. 15, NO. 5

EXECUTIVE STAFF — Sam C. Breder, director of customer service, center, confers with his top aides, Jack C. Zippwald, left, superintendent, and L. L. Underwood, chief coordinator, right, concerning basic sales policy.

AT YOUR

SOUTHWEST AREA — W. J. Hosmer, customer service representative, kneeling, confers at Douglas Aircraft Co. on Ryan products with Douglas officials, left to right, Bill Kavash, P. H. Thompson, B. O. Westberg.

MIDWEST AREA — A Ryan trio meet at Ford's Chicago plant to study J-57 jet production. Left to right, T. D. Lyne, of customer service; M. C. Ring and John Cameron, both of quality control. Ryan produces J-57 parts.



SERVICE

Ryan's far-flung Customer Service team renders skilled coast-to-coast service

THE meeting ground for buyer and seller at Ryan Aeronautical Company is its customer service department, through which flows the voluminous information that takes tangible shape on production lines.

In a sense, Ryan customer service might be likened to a two-way funnel. Into one end of this funnel pour data from the customer; into the other end come facts from the various Ryan departments on that customer's order. In the center, the men of customer service correlate the mass of material that reflects the buyer's needs and the seller's ability to meet those requirements.

If it were possible to find such a man, the ideal customer service employee would be simultaneously an engineer, production expert, accountant and a master of business law. For these are the fields he touches, and in actual practice at Ryan, the customer service man acquires a working knowledge of some of the fundamentals of each of these specialized skills.

The operations of customer service are not confined within the Ryan plant. They are as far-flung as the locations of its customers.

"Ambassadors" of Ryan customer service are the field representatives stationed in various strategic areas of the United States, primary centers of aircraft production and military aviation bases. These are the sales engineers who constantly keep customers and potential customers in their areas informed as to what Ryan is equipped to produce in high temperature components and airframe assemblies. They are new business-seekers.

Dean of this group is James B. Stalnaker, Jr., stationed in Seattle, and covering northwestern United States, with the Boeing Airplane Company as his major assignment. Stalnaker's employment at Ryan dates back 13 years.

Rod McDonough, Jr., veteran eastern customer service

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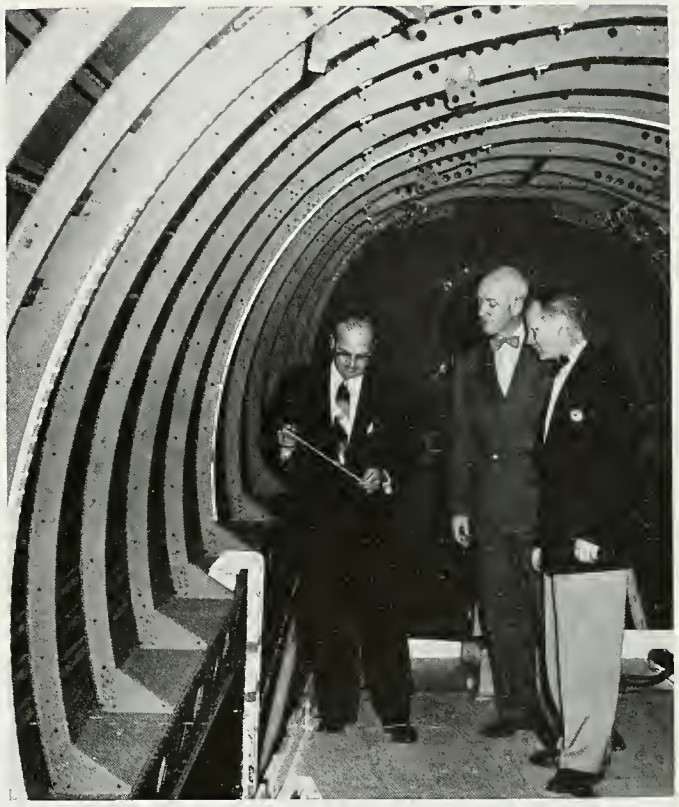
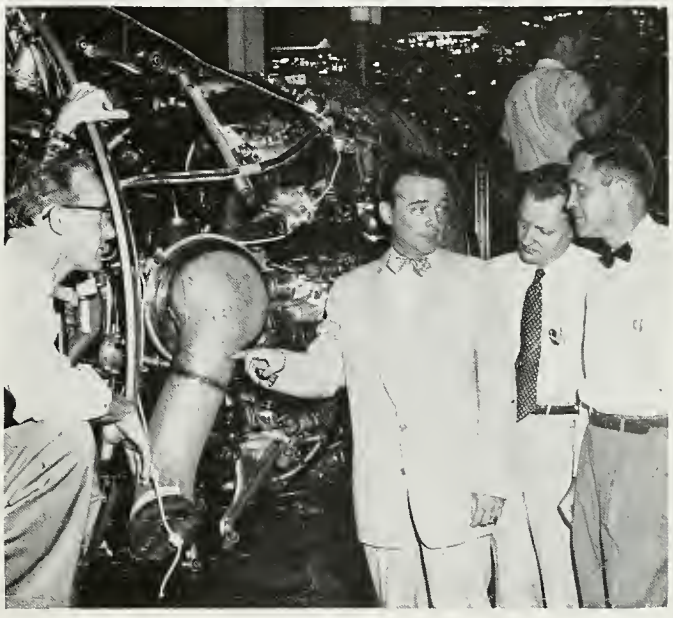
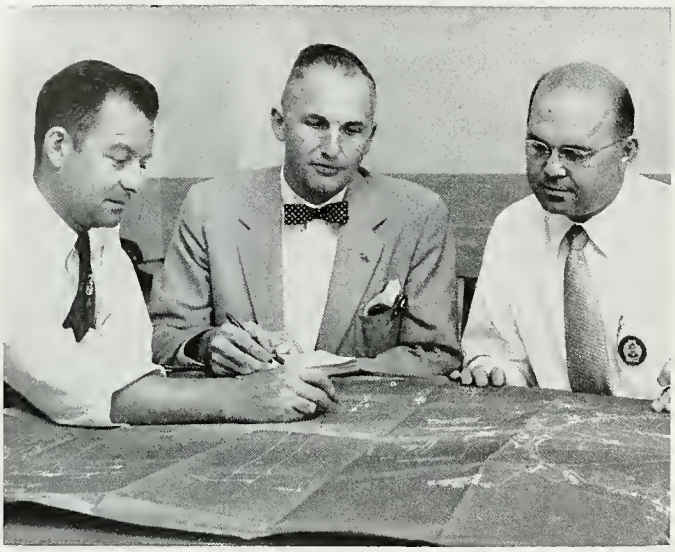


NORTHWEST AREA — James B. Stalnaker, Jr., at left, dean of Ryan customer service representatives, checks Ryan-built C-97 fuselage section with William Baihly, engineer, and Max Wilson, buying supervisor, at Boeing.

CENTRAL AREA — At General Electric's Evendale, Ohio plant, Roderick L. Zorn, of Ryan customer service, center, checks with Warren J. Nichols, manager of purchasing, and Bob Eckel, purchasing agent, on J-47 parts.

SOUTHEAST AREA — E. T. Flynn, of Ryan customer service, second from left, discusses Ryan armored hood at Fairchild factory, Hagerstown, Md., with Charles Fox, C. F. Murray and W. F. Slook, purchasing officials.





NORTHEAST AREA — Rod McDonough, Jr., center, Ryan customer service representative, confers at Pratt & Whitney Aircraft, Hartford, with Ernest Gagnon, vendar quality analyst, and Frank Oleksak, chief buyer.

SOUTHERN AREA — Wayne A. Stevenson, Ryan representative, center, discusses B-36 spares program with Otto Dworak, left, Convair chief of outside production at Ft. Warth, and T. O. Walthall, buying supervisor.

COORDINATORS — Watching over customers' interests at Ryan are coordinators, including left to right, Joseph J. Richert, Reynolds Winters, and Rex D. Smith.

representative operating out of the New York area, is assisted by Edward T. Flynn in covering the eastern seaboard from Canada to Georgia.

Working out of the Los Angeles office and dealing with customers from the Tehachapis to Long Beach is William J.

FIELD SERVICE — Gilbert M. Hansen, left, and C. L. Foushee, Jr., are Ryan's field service representatives, ready to fly anywhere in the world to assist military and commercial users.

Hosmer, a former major in the Air Service Command who was one of the first students trained at the old Ryan School of Aeronautics, where he obtained his private pilot's license in 1932.

(Continued on Page 31)

COORDINATORS — Also on coordinators' team, keeping tab on customers' needs through constant communications, are left to right, Jim Borders and Byron Geer.

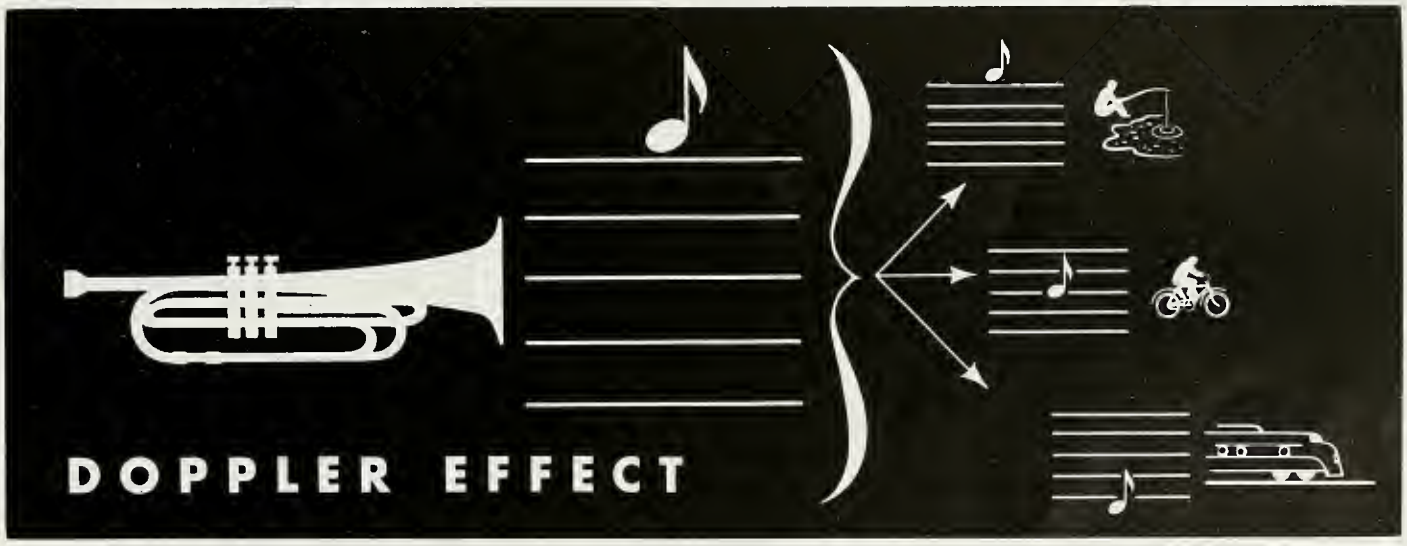
THEY CALL IT DOPPLER

The Austrian professor never dreamed of radio waves, but his theory plays a key role in modern electronics

IT WAS in 1711 that Alexander Pope wrote, "To err is human, to forgive divine." One hundred and sixty years later, a distinguished physicist was rejecting all claims to divinity when he said "The ingenuity of this theory is extreme, but its correctness is more than doubtful." He referred not to Pope's maxim, of course, but to a paper by an otherwise obscure Austrian professor of mathematics, Christian Johann Doppler.

The paper in question was published while Doppler was teaching mathematics in Prague, where he had gone at the last moment after planning to emigrate to America. It bore a German title whose unspectacular translation was "Concerning the Colored Light from Double Stars." And its major premise was wholly wrong. Nevertheless, it described a phenomenon which today underlies many important measurements and devices in astronomy and electronics, and it has gained a measure of immortality for its author.

What Doppler proposed in his paper was a special behavior by light waves and sound waves, which ought to occur whenever they came from a source which was either leaving or approaching the observer. Today, confirmation of the Doppler Effect is commonplace (for example, every time an airplane flies overhead), but it was not until 1845, three years after Doppler published his theory, that a Belgian obtained experimental verification for sound waves. The correct explanation for the case of light waves was offered by a French physicist, in 1848, and not until 1889 did Pickering of Harvard make the first valid application of the Effect to Doppler's original theme—double stars.



For Doppler had assumed that stars—all stars—emit substantially white light, and had hypothecated that the reason some stars appear colored lies in their motion toward or away from the earth. We know now that most stars do not emit white light, and even if they did, the Doppler effect would not change their apparent colors. Doppler reasoned that in the case of double stars—two suns revolving about a common axis—the rate of rotation could be measured by observing the apparent color of each star. So far, Doppler was wrong. Yet strangely enough, his explanation, for something which doesn't happen, proved eminently satisfactory for something which does.

Doppler's genius lay in seeing the distinction between sound or light, in themselves, and the sensations of pitch and color which they produce in an observer. At its source, sound or light energy is emitted as waves; that is, each second the energy of the source reaches a certain number of maximums, and an equal number of minimums. The energy spreads out from the source as in the classic example of the ripples created by a stone falling into a pond of still water. As the waves reach the eye or ear of an observer, the human mechanism effectively measures the rate at which wave crests (or troughs) are arriving, and assigns to that rate a qualitative value, such as "green," or "high note." This is illustrated in the top part of the adjacent illustration: the note coming from the trumpet sounds to the fisherman just as it does to the trumpeter.

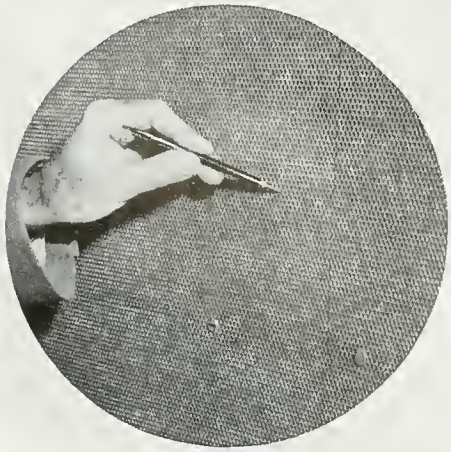
But suppose, reasoned Doppler, that the observer is moving toward or away from the source; then successive wave crests will be arriving either faster or slower than before, and the note will sound quite different. In the center of the illustration, our fisherman is pedaling a bicycle traveling away from the trumpeter, and he thinks he is listening to a French horn, because the wave crests are not catching up to him as rapidly as when

(Continued on Page 23)

Framed in the 7-foot opening to the exhaust chamber, Ryan plant engineer Charles Hasty examines the soundproofing labyrinth.

JET MUFFLER

Ryan filters the din out of decibels of jet engine noise



Surfaces of "Soundstream" units are perforated metal sheets which allow sound wave energy to pass thraugh to fibreglass absorbing material behind.

WHEN Ryan's new jet test cell roars into action soon, its voice will be hushed by the most advanced silencing equipment which acoustical science has devised. Largest facility of its type in the San Diego area, the new research tool will be used to test the nation's most powerful jet engines and afterburners.

Ryan is devoting $50,000 to the task of muffling the noise created by these seething power plants as they blast out tons of hot exhaust gases under full power tests. Direct beneficiaries of this investment in sound control will be Ryan employees, airport personnel and citizens of the surrounding community.

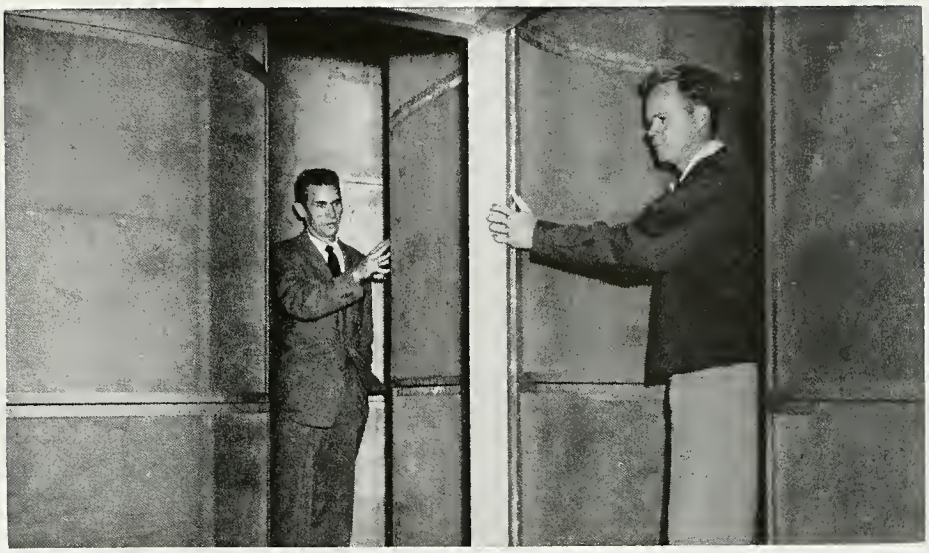
The silencing equipment will cut sound wave intensities to half their initial strength in most of the objectionable frequency ranges. Due to psychological reasons, slight changes in sound wave intensities account for substantial variations in hearing sensation. Therefore, this fifty percent reduction will acutally mean that the noise heard outside the jet test cell will be only one 1/100th the amount

which an unmuffled engine would create.

Stated another way, it means that employees immediately outside the test cell will be able to converse in normal tones when a jet engine is running with no more interference than would be caused by an unprotected turbojet operating at a distance of four miles away.

In contrast to many industrial noises, jet engines produce intense noise levels over a broad range of frequencies. Actually, they are somewhat like fire sirens in that both are good noise producers and function by passing streams of air through whirling blades.

Aeronautical silencers for jet engine test cells must be designed with aerodynamic and thermodynamic problems in mind, as well as to meet the acoustical requirements. For example, air inlet silencers must provide for a minimum of turbulence and pressure loss. Exhaust silencers must handle fiery gases which have initial temperatures that can soar as high as 3200°F.



Walls of the silencing equipment, designed and built by Industrial Sound Control, Inc. for the Ryan jet test cell, are inspected by ICS and Ryan engineers. Sound is trapped and absorbed in maze-like passages walled with "Soundstream" units.

Designed by plant engineers, the Ryan test cell is a monolithic concrete vault with three major openings. These are two towering air inlet stacks and an exhaust chamber, fed by a 7-foot diameter tube. Since the massive two-foot thick walls of the cell conduct very little sound, the major sources of concern are the three openings. To muffle these avenues of noise, especially-designed silencing equipment has been fabricated by the Industrial Sound Control Corporation of Hartford, Connecticut.

This equipment consists of assemblies of ICS's "Soundstream" units which are engineered to trap and absorb specific types of sound. Each unit is a perforated metal structure of sinusoidal configuration. They are filled with uniform layers of fiberglass material held in place with steel wire mesh. The units are installed in overlapping labyrinths designed to dissipate and absorb sound waves.

To get a good conception of the problems involved in silencing Ryan's jet test cell, it is necessary to understand the nature of noise. Noise is sound that disturbs, annoys or actually pains the ears of human beings. Sounds which are pleasing usually have a regularity of frequency and intensity for which the ear has been conditioned. The annoyance level of sound depends upon its frequency as well as intensity because the ear and nervous system are more sensitive to high pitched sounds than those of low frequency. Consequently, a silencing system, such as that installed at Ryan, must be efficient in attenuating sound intensities in all of the frequency ranges where objectionable sounds are transmitted.

It's impossible to analyze sound without separating the subject into two parts: sound waves and the ear and brain which interpret them as sound. It has been said that no sound would occur from an explosion in a desolate region if no living thing heard it. That's true, because sound is not sound until it is interpreted as such by the ear and brain. Before that, it is simply a silent movement of molecules of air, water or whatever the transmitting medium happens to be.

Sound is a nice example of the propagation of energy by longitudinal wave

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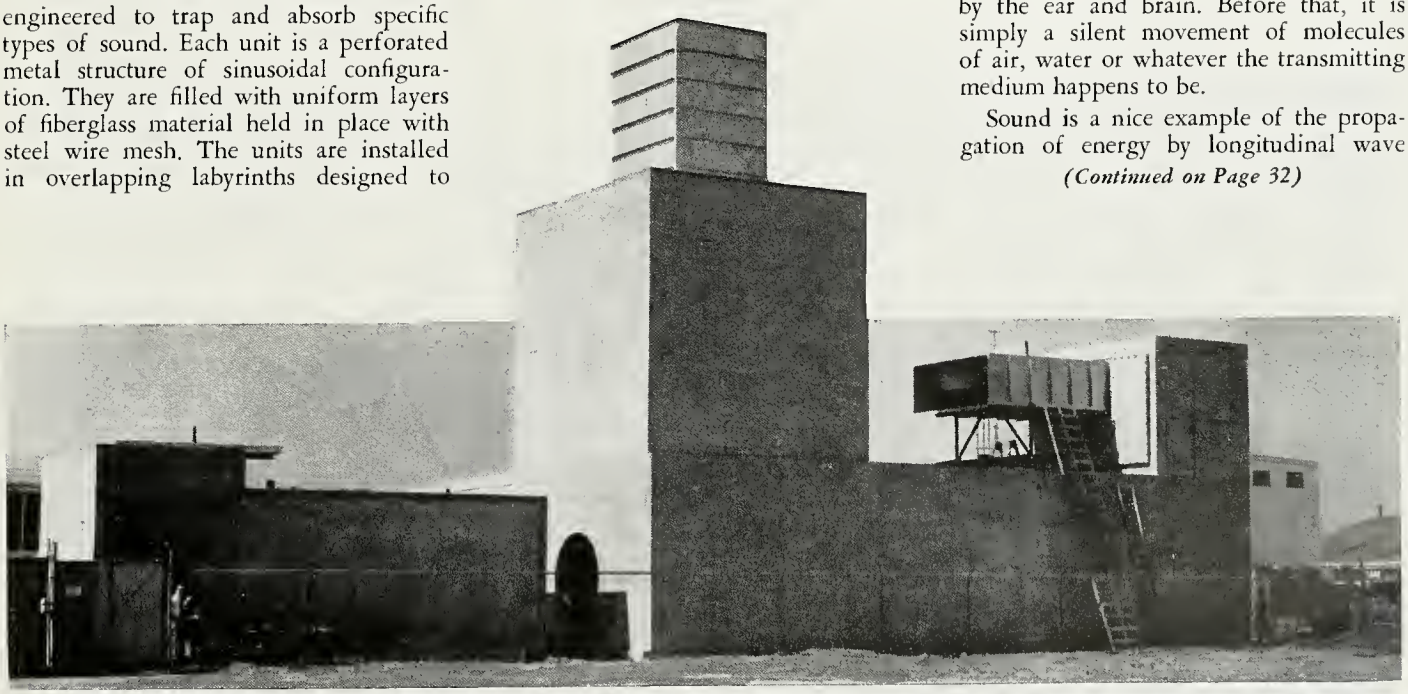

Nearing completion, Ryan's test cell will advance knowledge of high temperature metallurgy and jet propelled flight problems.

Flight tests of the Navy's first tip-powered jet helicopter, the Hiller HOE-1, are continuing at the Hiller plant in anticipation of delivery of an evaluation quantity in near future.

The Engine Goes Round And Round

A TINY engine that goes round and round at opposite tips of a rotor provides the power for one of America's most unusual aircraft, the Hiller Hornet Ramjet Helicopter.

Ryan is assembling these compact power plants which weigh only 11 pounds and contain no moving parts. Replaceable in three minutes with a screwdriver, the unique engine may bring closer to realization the practical use of "midget" helicopters for military and commercial applications. As of this writing, the C.A.A. has been conducting certification tests, and a limited number of the craft have been ordered by the Army, Navy and Marines for evaluation purposes.

The Navy-designated HOE-1 is that service's first tip-mounted jet helicopter, while the Army-designated H-32 is its first operational ramjet helicopter.

Known popularly as the Hornet, the helicopter is a two-place rotary wing aircraft with 23-foot rotor blades driven by the small ramjet engines at the blade tips. The entire craft weighs little over 500 pounds, but can lift more pay load than its weight.

(Continued on Page 33)

Hiller Hornets powered by Ryan-built Ramjets

Ryan workers assemble tiny power plants for one of America's unique aircraft, the Hiller Hornet Ramjet Helicopter. Engine weighs 11 pounds, has no moving parts, is quickly replaceable.

Ground tests of Ramjet engines are conducted on "whirl" test stand. Hiller engineers believe tip-powered system will be adapted to large as well as small helicopters of the future.

Tomorrow's Tankers Today

Boeing adds jet speed to military tanker-transports

WITH the evolution of American air power rapidly nearing the all-jet stage, an increasing emphasis has been placed upon the business of transferring fuel from one airplane to another while both are in flight. It is by this means alone that our fuel-hungry intercontinental jet bombers are capable of delivering paralyzing retaliatory blows to the solar plexus of an aggressor.

Recent years have seen refueling techniques refined to such an extent that in-flight refueling has become routine. Now needed: a tanker aircraft that can keep pace with the globe-shrinking speed of our newest jet bombers and fighters, and refuel them at their cruising altitude. In other words, a jet tanker.

Anticipating this need, Boeing Airplane Company has invested $15,000,000 in company funds in an answer . . . the 707 jet tanker-transport prototype. Since its historic maiden flight at Renton, Washington, airport on July 15, this sleek new swept-wing giant already has flown to altitudes above 42,000 feet and speeds of more than 550 miles per hour.

An Air Force decision to buy a limited number of the new tankers was announced on August 5 by Secretary of the Air Force Harold E. Talbott. The production model will be an advanced version of the Boeing 707 currently undergoing flight tests, and will have a considerably greater refueling capacity.

The Boeing prototype was built for a dual purpose: to demonstrate to the Air Force the capabilities of the design as a tanker-transport able to keep up with the latest jet bombers and refuel them enroute to target, and to demonstrate to the airlines its capabilities as a very-high-speed transport. Hence, it was christened with the double name, Boeing Jet Strato-

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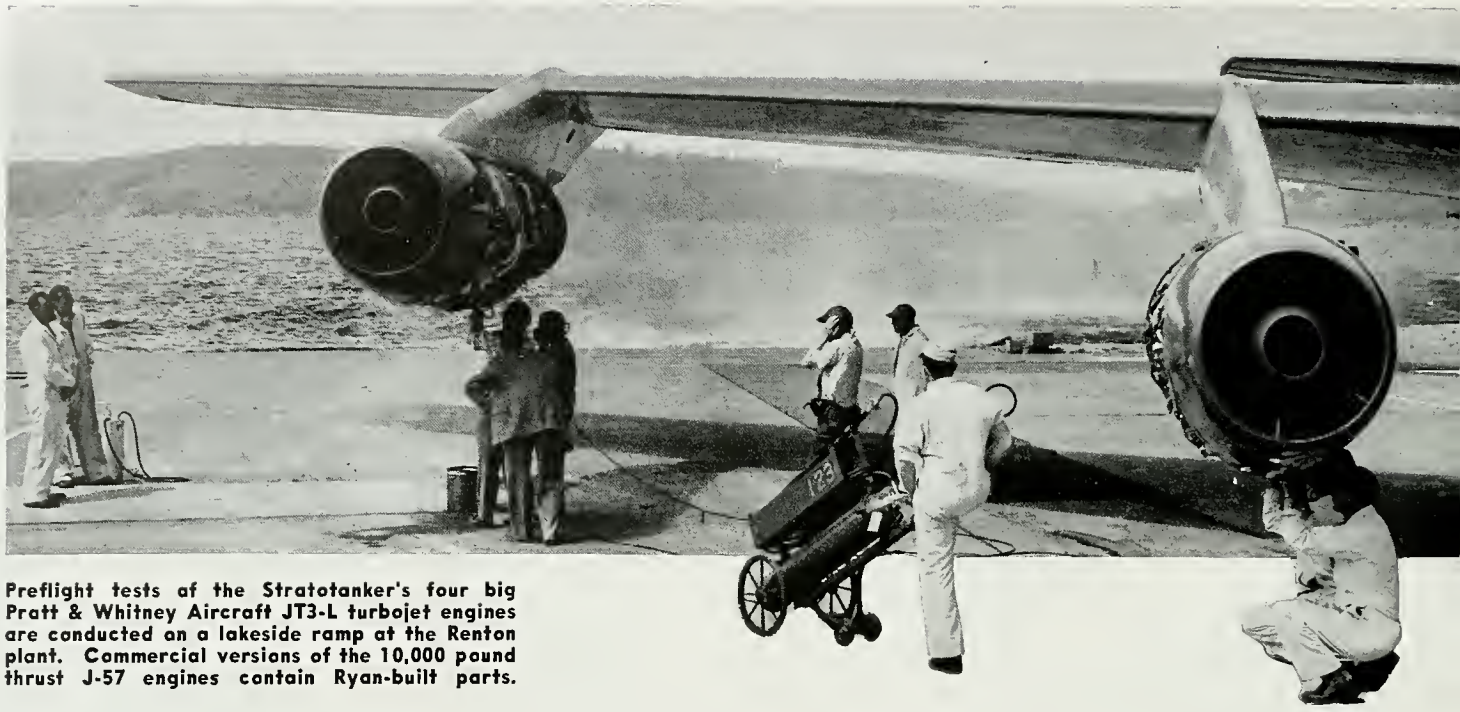

Preflight tests of the Stratotanker's four big Pratt & Whitney Aircraft JT3-L turbojet engines are conducted on a lakeside ramp at the Renton plant. Commercial versions of the 10,000 pound thrust J-57 engines contain Ryan-built parts.

tanker-Stratoliner.

As a military model, the Stratotanker will be capable of high-speed, high-altitude refueling of existing and future jet bombers, fighters and other combat aircraft, and will make possible high-speed world-wide transport of men and supplies. It should prove a worthy successor to the present widely used Boeing KC-97, the Strategic Air Command's standard piston-powered tanker for which Ryan Aeronautical Company builds aft fuselages, refueling pods, cargo doors, floor beams, external fuel tanks and exhaust systems.

Boeing predicts that the commercial version will be capable of regular transcontinental non-stop flights in less than five hours, and non-stop New York-London schedules of less than seven hours. It will carry from 80 to 130 passengers, cruising at an optimum operational altitude between 30,000 and 40,000 feet.

Painted in a fetching canary yellow, chocolate brown, white and silver color scheme, the prototype is powered by four Pratt and Whitney Aircraft JT3-L turbojet engines slung in streamlined pods below the wing. Rated at 10,000 pounds thrust, the engines are commercial versions of the famed J-57. The wings are swept back approximately 35 degrees and have a span of 130 feet. Length is 128 feet and gross weight 190,000 pounds.

The airplane is now based at Boeing's new $5,000,000 giant flight test facility at Boeing Field in Seattle, where it has entered the initial phases of a concentrated flight test program. A. M. "Tex" Johnston, Boeing's chief of flight test who was at the controls during its first flight, is flying the 50 carefully charted flight hours comprising the first phase of the test program.

The new Boeing jet is backed by the world's most extensive experience in the design and production of aerial tankers, as well as large, high-performance, multi-jet aircraft. It is the third large swept-wing jet aircraft type built by Boeing. The six-jet B-47 Stratojet bomber, which made its first flight in 1947, was the first of them, followed in 1952 by the eight-jet B-52 Stratofortress. They, along with the KC-97 tanker, are now in quantity production for the Air Force's Strategic Air Command.

J. B. Stalnaker, Ryan representative at the Boeing Airplane Company, is dwarfed by the huge Stratotanker prototype as he discusses it with an official of Boeing.

It is from these noble ancestors that the Stratotanker-Stratoliner design has evolved. Modified characteristics of each have been incorporated in the new plane —its airframe is basically that of the KC-97 with the wings and engine pods of the B-52 and the tail of the B-47. The result is a modern transport with the performance of many contemporary military jet aircraft.

In its role as the eventual successor to the KC-97, the Stratotanker must match an impressive service record. It was with the KC-97 that aerial refueling came fully of age, endowing our strategic and tactical air forces with great flexibility and the capability of striking much deeper into enemy territory.

More than 500 of these versatile tankers serve the units of the Strategic Air Command. With them SAC is making contacts with other airplanes for aerial refueling on an average of once every 15 minutes. One KC-97 equipped Air Refueling Squadron—the 305th, based at MacDill AFB, Florida—recently passed the 3,000,000 gallon mark of fuel delivered by the unit. Squadrons of land-based fighter aircraft, noted for their comparatively short range, have straddled oceans with the help of the KC-97s.

Moving off the assembly line at Boeing's Renton plant at a one-a-day pace, the big KC-97s contain many parts fabricated at Ryan, which is located more than

a thousand miles away. Biggest Ryan-built components are the aft fuselages which are 38 feet long and 11 feet in diameter.

It is interesting to note that Boeing, in addition to designing and building the "flying gas stations" that have made aerial refueling a routine business, also played a leading role in the development of aerial fuel transfer devices. Efforts along this path began in late 1947 when the Air Force called on Boeing to devise a practical means of transferring fuel to a bomber in mid-air.

Aerial refueling was not in itself a new concept. The first successful mid-air refueling of an airplane was accomplished as long ago as 1923 when two Army pilots, Lts. L. H. Smith and J. P. Richter, stayed in the air four days over San Diego. In 1929, the San Diego-based *Question Mark,* piloted by Major Carl Spaatz and Captain Ira C. Eaker, stayed aloft over Los Angeles for more than 150 hours by means of air-to-air refueling. However, the devices used in these early achievements were for the most part crude contraptions of cable and hose—hardly suitable for the refueling of modern, high-speed aircraft.

The first successful Boeing fuel transfer, from one B-29 to another, was made at Boeing's Wichita division in 1948. Although it demonstrated the feasibility of refueling large bombers, the initial transfer system did not meet the rapid fuel transfer requirements of the U. S. Air Force.

It was soon followed, however, by the development of a functional hose-type apparatus adapted from new British-designed equipment. This was mated to a modified series of wartime B-29s for refueling work, and the U. S. Air Force had a new aircraft type—the military tanker. Seeking still a better transfer system, Boeing later developed a new type of refueling apparatus, an extendable pipe which came to be known as the Flying Boom. It is with this device that the KC-97 has established its remarkable record as an aerial tanker.

The present and future of aerial refueling are represented in this photograph of the new Boeing Stratotanker parked alongside the present Air Force tanker-transport, the Boeing KC-97G Stratofreighter. Moving off Boeing's assembly line at a one-a-day pace, the huge KC-97's contain many parts built by Ryan.

In view of the 707 Stratotanker development, it is only logical that Boeing's latest interest should center around high-speed, high-altitude refueling techniques employing jet tankers. Boeing and the Air Force recently completed the preliminary phases of an experimental aerial refueling project in which a jet-powered tanker was used for the first time. Two B-47s, one modified for service as a tanker, took part.

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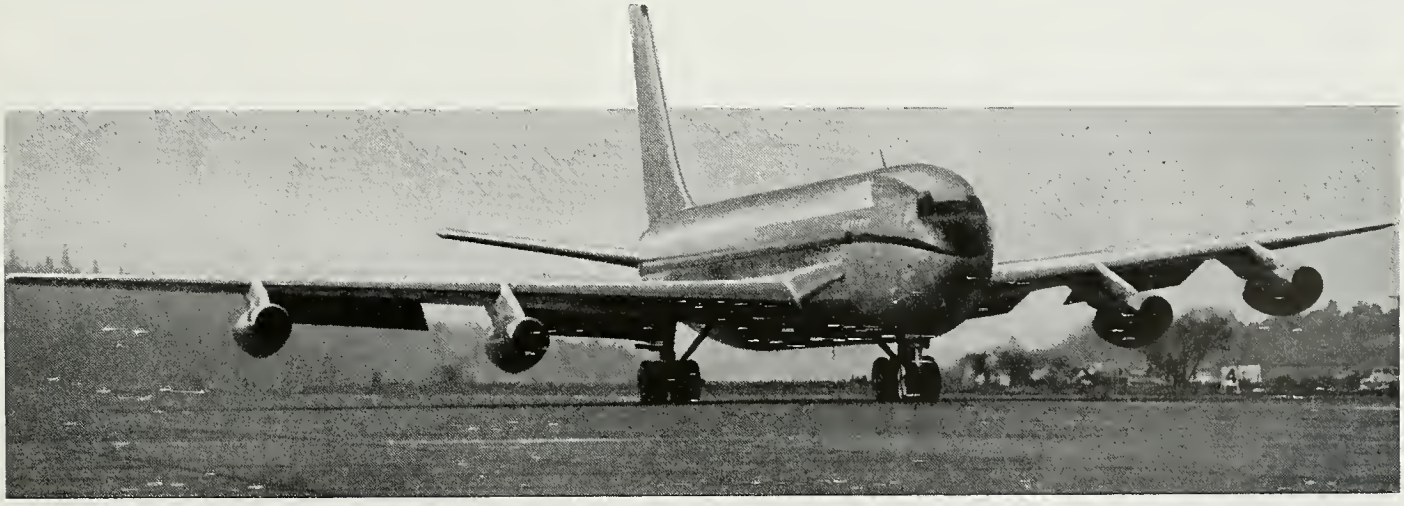
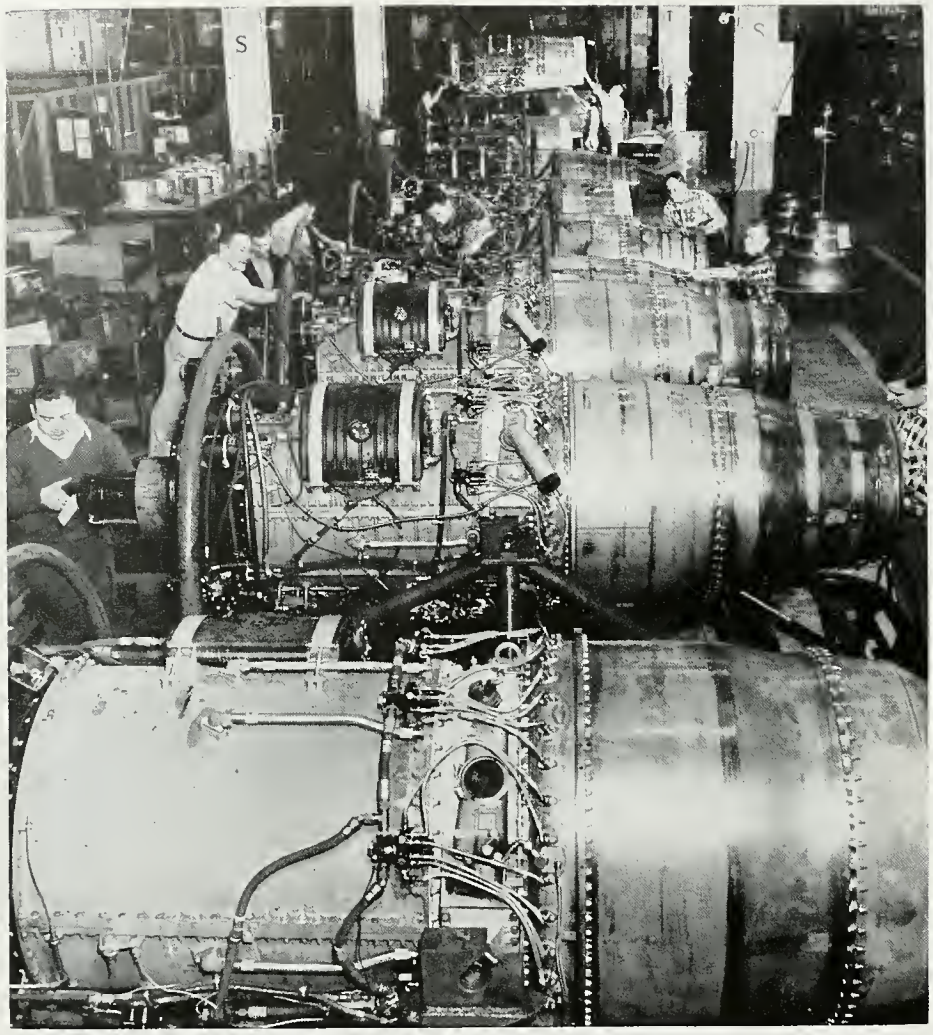


This view of the Boeing 707 prototype rolling along runway following a test flight shows unusual eight-wheel main landing gear.

DOING

Versatile C



Line of Curtiss-Wright J-65 turobojets receives last minute inspection in preparation for shipment. Rated at 7220 pounds thrust, the J-65 has excellent growth potential.

REVEALED recently to be the power-plant chosen for three of the nation's latest military aircraft, the Curtiss-Wright J-65 engine is now installed in more top-rank plane types than any other U. S. turbojet.

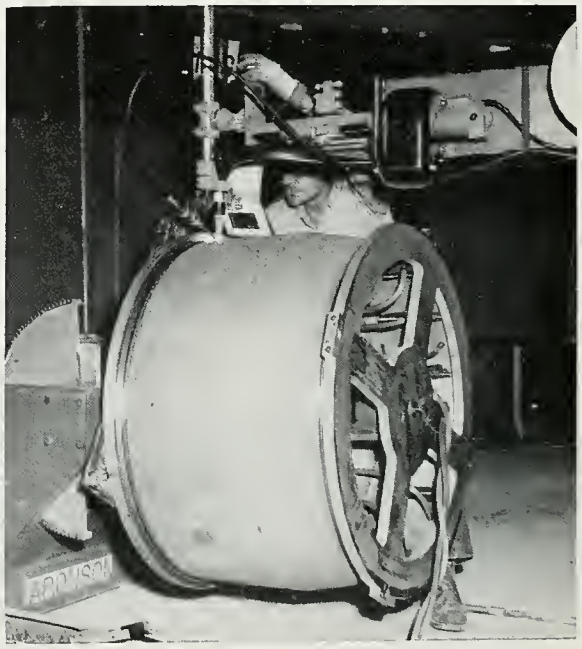
Within the past few months, the J-65 has been announced as the engine in the Grumman F9F-9 Tiger, a Navy fighter capable of exceeding the speed of sound in level flight; the Lockheed XF-104, a high-speed day fighter for which no performance figures have been announced; and the Douglas A4D Skyhawk, a bantam-sized bomber built for the Navy and capable of carrying an atom bomb.

Added to these, bringing the list of installations for the J-65 to seven, are the previously announced North American FJ-3 Fury, Navy fighter; the Republic RF-84 Thunderflash reconnaissance fighter operated by the Air Force; the twin-jet Air Force Martin B-57 Night Intruder bomber; and the Republic F-84F Thunderstreak, an Air Force fighter-bomber rated at more than 600 miles per hour.

Many of the precision built, sheet metal

George E. Davee, Ryan welder, is shown welding flanges on a housing assembly for the Wright J-65. Ryan also builds the afterburners of the J-65 turbojet.

One of the world's few combat aircraft capable of supersonic speed in level flight, the Navy's new Grumman F9F-9 Tiger is powered by a J-65 with an afterburner. The new plane brings to seven the total number of top-rank Air Force and Navy aircraft types equipped with the J-65 jet.



IT THE WRIGHT WAY

ss - Wright builds every major powerplant type

components for the Wright J-65 are being produced by the Ryan Aeronautical Company which also supplies segmented nozzle boxes for the famed Curtiss-Wright R-3350 Turbo-Compound engine. Ryan-built J-65 parts include two different engine housing assemblies as well as valves, cones and ducts, shields and other welded and machined-member assemblies. Ryan also produces the afterburner for the J-65.

Produced in Curtiss-Wright's Wood-Ridge, New Jersey plant the J-65 is a high-capacity engine delivering more than its guaranteed 7220 pounds of thrust and has an excellent growth potential.

It is approximately 25 percent more powerful than the jet engines it is replacing in the military program. The FJ-3, for example, is a more powerful Navy version of the F-86 Sabre.

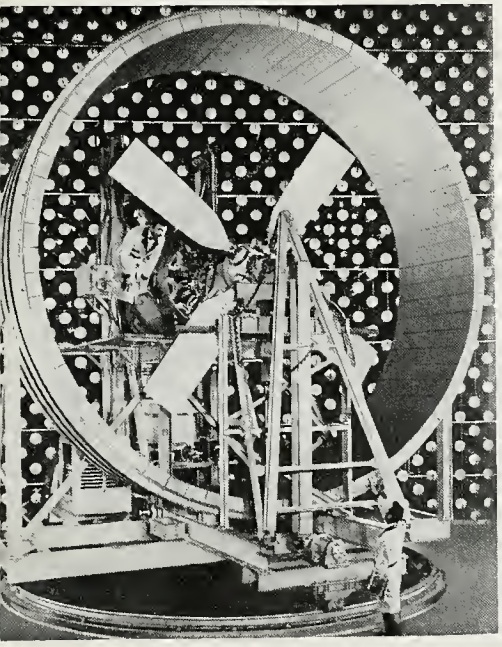
Field experience has shown that the J-65 uses up to six percent less fuel than specification, thus increasing the expected range of all aircraft powered by this Curtiss-Wright jet.

Its high efficiency and power have also

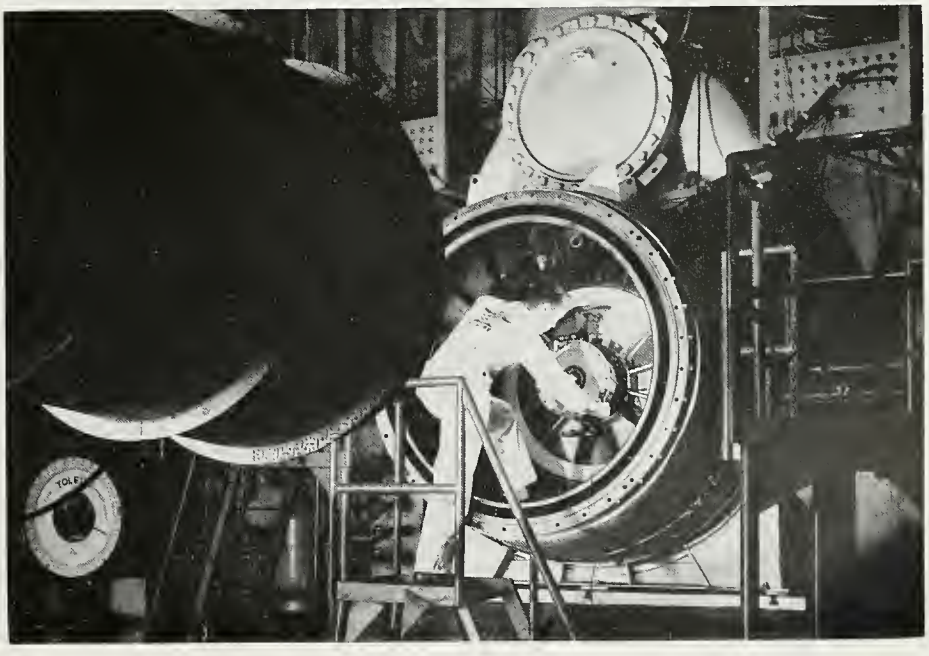
(Continued on Page 24)

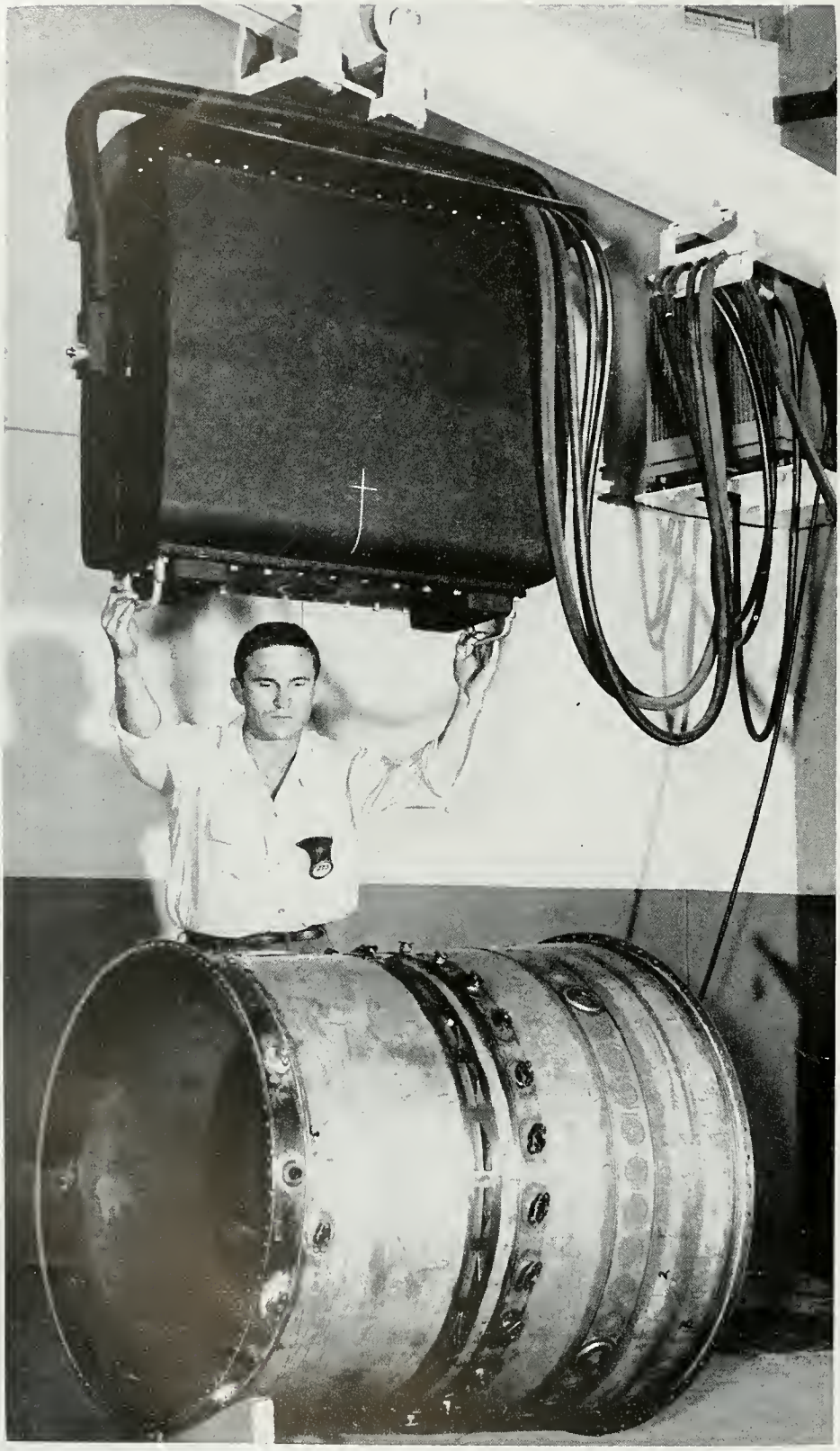
Framed in a Ryan-built jet engine part held by Roy T. Hurley, chairman of the board and president of Curtiss-Wright Corporation, United Air Lines stewardess Kay McCabe makes a pretty picture. Component is an inlet housing assembly for the J-65 engine.

Gyro whirl rig is an impartant development aid to Curtiss-Wright's Propeller division. Rig permits evaluation of propellers under conditians simulating those found in flight.



This is one of two compressor cells in the Turbine Development Laboratory at Wright Aeronautical Division. Compressor is mounted in opening where engineer is shown and can then be tested or used to provide large air flows for other types of work. Three electric motors developing a total of 15,450 h. p. are used to turn the compressor.





A GROUP of employees at Ryan fire electrons from cathode "guns," create magnetic fields and bathe metal in ultra violet radiation. Scientists in the laboratories? No, they are production line inspectors using science's advanced techniques to detect the slightest flaws in the metallic structure of Ryan components for jet engines, afterburners, rockets and ramjets.

In the 17th Century, Galileo opened the eyes of astronomers with his telescope. For the first time, men saw the mountains of the moon and observed the cosmic world, which was too distant to see with the unaided eye. The perfection of the microscope revealed the microcosmic world—a universe close at hand but too infinitesimal to see. Both worlds lie beyond the range of the human eye, just as many sounds are pitched too low or too high for the ear to hear.

With the microscope, "mountains" were discovered on the sharpened edges of razor blades and the fine points of needles were found to be truncated cones. The microscope pioneered the science of metallurgy and established manufacturing on a precision basis. Today, Ryan builds precision components for jet engines and extremely delicate electronic guidance systems for missiles because of these developments.

But, precision alone is not enough. Gleaming combustion chambers, seething afterburners and fiery rocket motors have to be as perfect internally as they are accurate dimensionally. To insure this structural soundness, Ryan inspectors must look beyond the clean, hard geometry of the metal surfaces and peer deep into the heart of the alloys themselves. To do this, the newest "eyes" of science are harnessed—"eyes" which can see far beyond the microscope.

X-RAY

Most striking tool of this type is the X-ray machine. Ryan has stepped up its X-ray facilities and now has two complete installations capable of handling large volumes of work. X-rays are a form of

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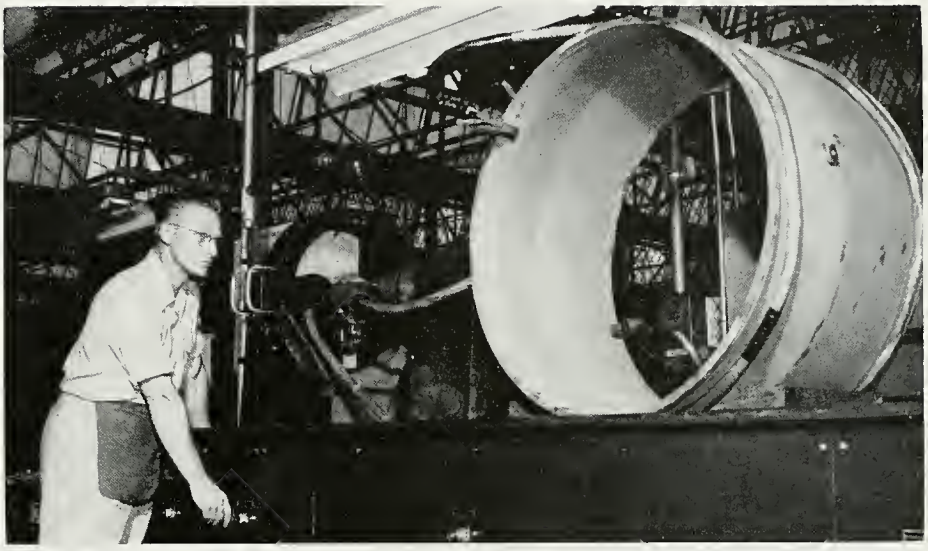
Ryan's 250,000-volt X-ray tube is positioned over large jet engine casing by Wm. Hogue. Machine will penetrate 4½ inches of steel.

METAL SLEUTHS

Electrons sharpen the Private Eyes of science

Clear as a fingerprint, a spectrogram tells Ruth Adams which elements are present in the alloy which was tested.



Nello Giddens magnetizes a large J-65 jet engine component by passing an electric current through it in a Magnaflux machine. If any surface defects are present, they will be detected by the magnetic particles which are attracted to the poles formed.

radiant energy similar to light waves in that they travel in straight lines, traverse empty space and affect photographic emulsions. They differ from light waves in that they are much shorter. Visible light falls within a range where the waves are between 3000 and 7500 Angstrom units long. (One Angstrom unit is 1/250 millionth of an inch) X-ray wave lengths run from .05 to 2 Angstrom units. Because of this short wave length, X-rays can penetrate deep into solid matter which is opaque to light waves.

Ryan X-ray technicians produce these discerning waves with a Coolidge tube which bombards a metal target plate with a fast moving stream of electrons. As the swift electrons crash into the metal plate, their kinetic energy causes the metal to radiate streams of X-rays. These are focused and directed through the metal part

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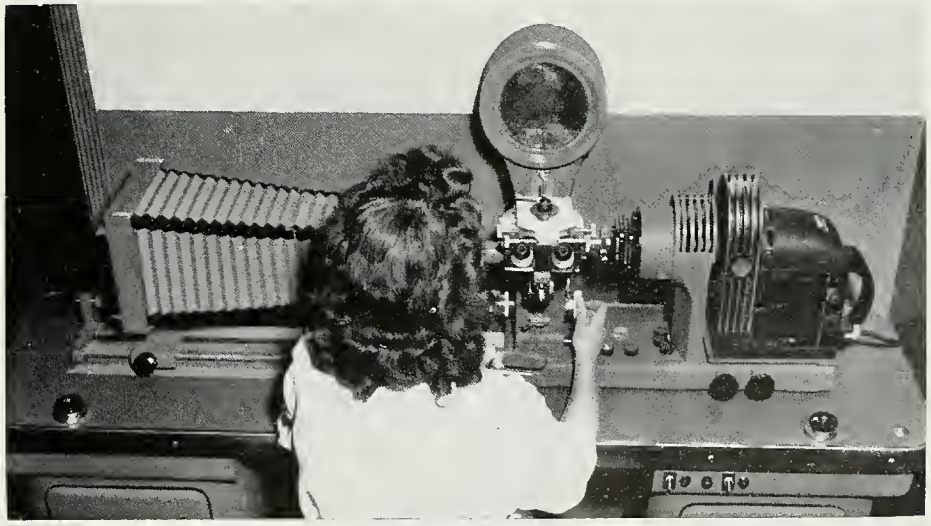
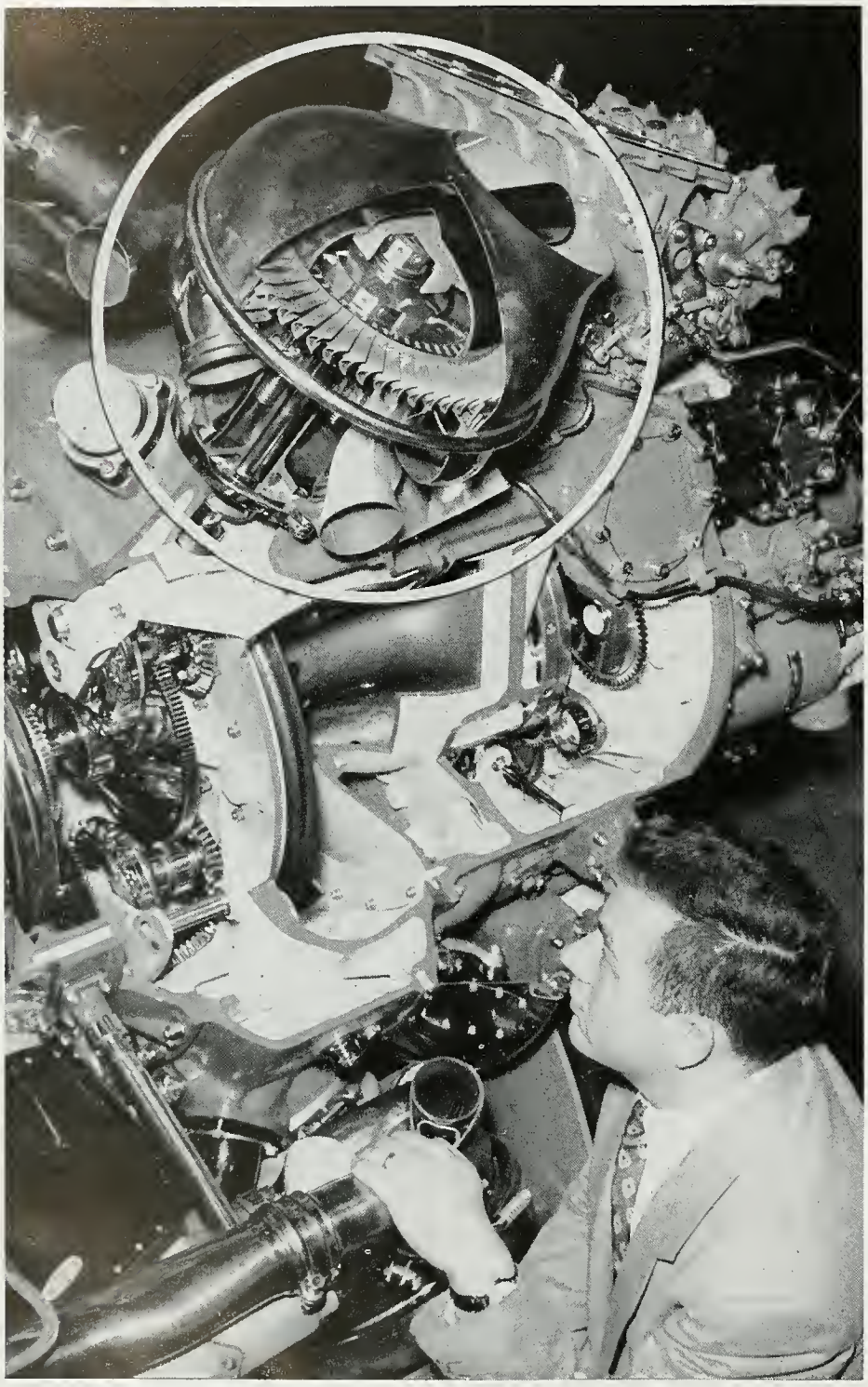


One of the most valuable metallurgical instruments in the Ryan Laboratory is the metallograph. This new $6000 model will help Ryan metallurgists peer deeply into the microstructure of metals to observe the characteristics of their grain structure.

Modern Zyglo system is used to subject jet engine parts to fluorescent penetrant inspection at Ryan. William Richards (left) sprays parts with the fluorescent particles while Wallace Underwood prepares them for viewing in ultra-violet booth.

With the Spectrograph, Lab Chief Wilson Hubbell takes a photograph of the light emitted by vaporized Inconel particles.



DOUGHNUT-shaped components produced at Ryan Aeronautical Company are helping provide the exceptional performance of some of the most advanced piston-engined aircraft in the world.

These key units are the nozzle boxes for the remarkable 18-cylinder Wright R-3350 Turbo-Compound aircraft engines, which utilize formerly wasted heat energy to generate 20 percent additional power with no greater fuel consumption. Among planes which have been using this engine are the Lockheed P2V-4 Navy Neptune, the Martin P5M Navy Marlin flying boat, the Fairchild C-119 Air Force Packet cargo plane, the Lockheed Super Constellation and the Douglas DC-7.

Through these nozzle boxes are funnelled the high-temperature gases which exhaust from the cylinders. These fiery blasts are directed into a turbine wheel, which the gases spin at high speed. The turbine is fixed to a shaft, which in turn is coupled to the engine's main crankshaft. The chain reaction imparts additional power to the propeller. Each engine requires three nozzle boxes, and each nozzle box utilizes the exhaust gases from six cylinders.

Fabrication of the nozzle boxes posed intricate problems—primarily of welding and of maintaining extremely close tolerances. Adding to the challenge was the need for rapidly accelerated deliveries in a "crash" production program.

The nozzle boxes actually consist of three separate segments which, when bolted to a solid machined ring form a doughnut configuration. The original forming of the base stampings is performed in the drophammer. Holes for the bolts are drilled in the machine shop, where an angle cut is made at the point where a butt weld attaches the tube to the base stamping.

After this welding, the part is sandblasted, weld-checked in inspection, and

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Encircled is turbine wheel assembly of Wright Turbo-Compound. Ryan nozzle box assemblies direct previously wasted exhaust gases against wheel to boost power.

PLUS POWER

Ryan nozzles help give the piston engine a new lease on life by funneling exhaust gases

Two Curtiss-Wright Turbo-Compound assembly lines show engines, at left, never run before, and once-tested engines being reassembled.

hand-flattened. Then the details, such as machined flanges and wear bands, are installed.

The heliarc welding calls for the greatest skill due to the fact that some of the irregularly shaped joints are almost inaccessible. Ryan's long experience in problems of welding high-temperature components for aircraft engines has enabled it to tackle and overcome the inherent difficulties in this project.

Wright requires that the parts be held to tolerances of .005"—minutely fine tolerances for sheet metal assemblies. This means that the flanges must not vary more than .005" from flat. In addition, the plane of one flange with relation to the plane of another must be maintained to within plus or minus .010".

Thus, after every weld and alignment, a hand-flattening operation is necessary, using special gauge blocks to assure retention of the required tolerances. Painstaking manhours go into the fabrication of the nozzle boxes to insure perfection.

Production of these components is in Inconel, which has a high nickel content. Ryan is building 15 test sets from 19-9DL Uniloy—an alloy with a lower nickel content—to determine if this less expensive material will be feasible.

In the early stages of production, 100 percent X-ray inspection was required of all detailed parts. As the work progressed, dye penetrant inspection was approved for most parts, with X-ray still used occasionally. (See "Metal Sleuth," Page 12, in this issue of "Ryan Re-

(Continued on Page 27)

Among America's foremost commercial airliners using remarkable Wright Turbo-Compound is Douglas DC-7. Also equipped with this engine is Lockheed Super Constellation.

Guy Keller displays the doughnut-shaped nozzle box, key unit in Wright engine.

DESIGNED TO GO

A FAR FROM GLAMOROUS, yet very important problem associated with missile-type aircraft is logistics. Unlike conventional aircraft, missiles cannot be ferried from factory to duty station—they must be shipped. And this must be accomplished in much the same manner as a crate of eggs

While the accuracy of a comparison between eggs and missiles is certainly debatable, there exists, nevertheless, a definite similarity between the two as far as shipping is concerned. Just as the eggs must arrive at their ultimate destination unbroken, still fresh, and ready for the frying pan, so must the missile arrive—its delicate mechanisms intact and unharmed—ready for immediate assembly, test and flight.

There the similarity ends, for the missile, unlike the eggs, is not always uncrated and used right away. Instead, it may be left in its crate and stored for a long period of time—its components not to be assembled until its use is required.

Ryan engineers had these factors in mind when they designed the Firebee pilotless jet target drone. As a result, the Firebee incorporates a breakdown scheme aimed at rapid assembly, simplified maintenance and easy shipment.

Somewhat less than half the size of a present-day jet fighter aircraft, the Firebee target is a mid-wing, all-metal pilotless aircraft with sharply swept-back wings and tail surfaces. The 1800-pound airframe has a span of approximately 12 feet, a length of 18 feet and a height of six feet. Power is provided by a Fairchild J-44 or Continental-Marbore J-69 turbojet engine of 1000 pounds thrust.

The Firebee is designed for easy assembly. Construction is aluminum, magnesium and stainless steel in five major assemblies—fuselage, nacelle, wing, empennage and parachute container (tail cone). Simple four-point attachments and self-aligning bolts make it possible for two or three men to assemble or disassemble the complete target in little more than an hour.

By packing more than one major assembly in each, the Firebee shipping containers are few in number and take a surprisingly small amount of shipping volume and storage space. The Navy KDA-1 version, for example, is shipped from the Ryan factory in a group of only four containers with a total weight of approximately 2,500 pounds.

Largest and heaviest of these is the crate in which the fuselage and nacelle (complete with engine installed) are packed. For shipping purposes, the two major assemblies are combined as one and mounted on two padded wooden saddles which are anchored to the base of the crate. The base has another highly practical function in that it serves as a handling fixture for the Firebee while the latter is still on the production line.

The next largest container holds the wing and empennage assemblies. These also are secured to padded wooden saddles which are anchored to the base of the crate. The two remaining boxes contain (1) the parachute's tailcone, and (2) the main parachute, drag parachute, parachute swivel, log books and records. Miscellaneous loose parts and components are contained in a small box which is secured to the base of the fuselage nacelle

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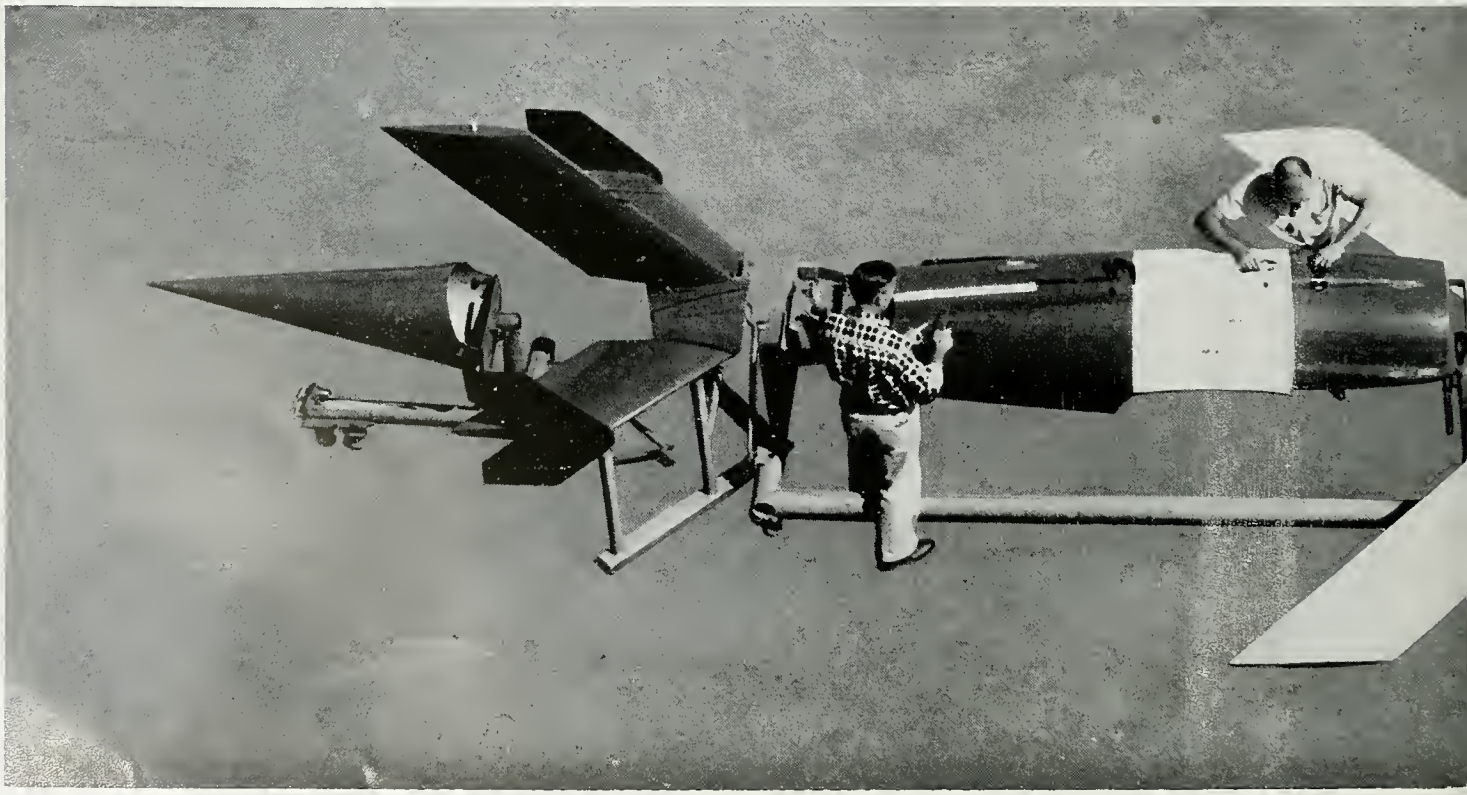
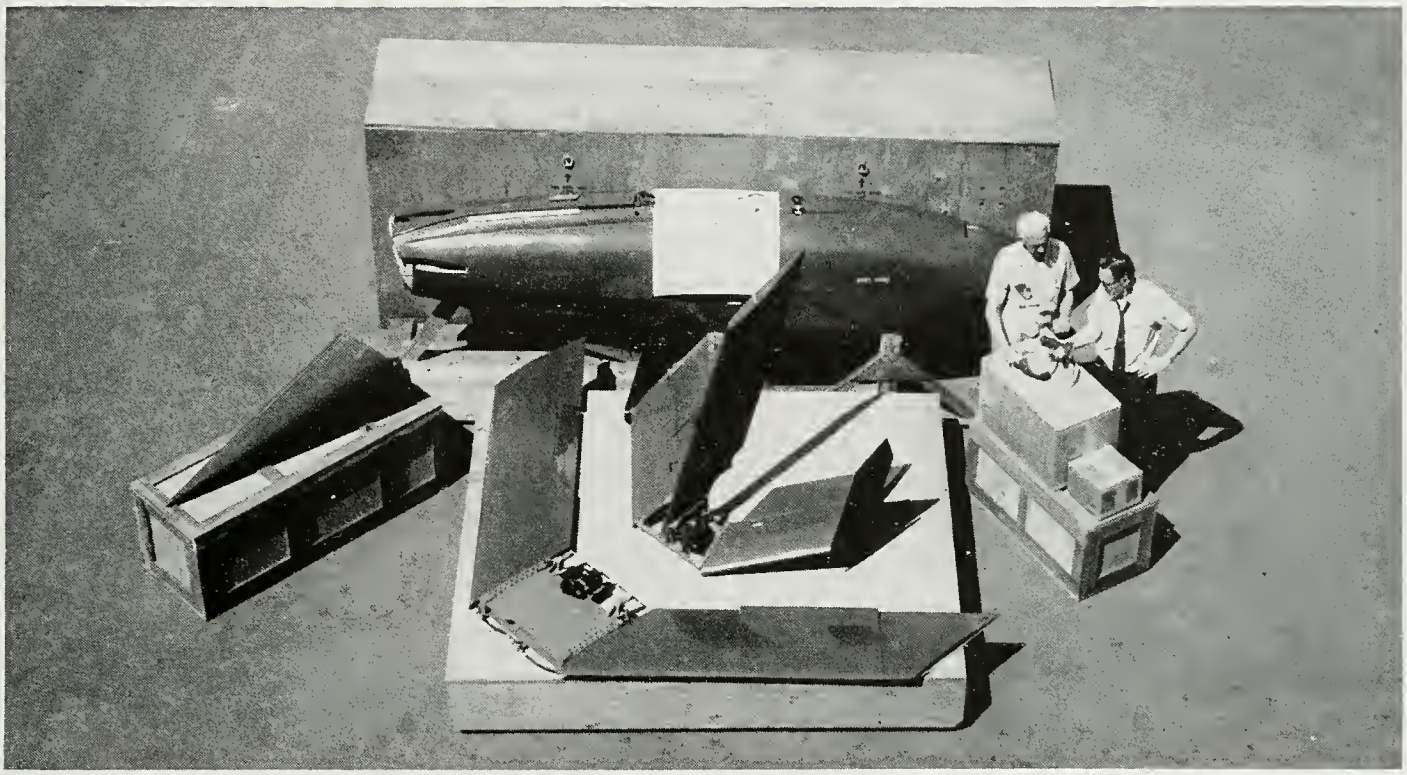
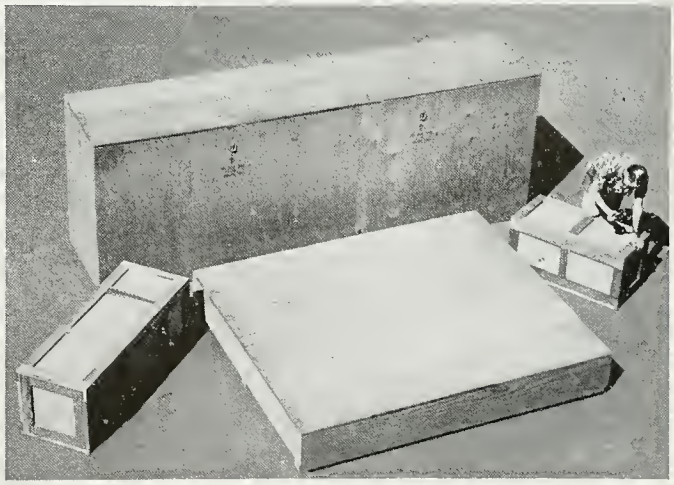




Firebee assemblies are shown with their respective containers. Wing tips and vertical stabilizer are removed for ease in shipment.

PLACES

Simple Firebee design makes shipment of the drones easy



Ready for shipment, the assemblies have been crated in water-resistant plywood containers which are designed for limited re-use. Total weight of four containers is only 2,500 pounds.

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Lined up opposite attachment points, the Firebee components are ready for rapid assembly. Self-aligning bolts and simple four-point attachments make it possible for two or three men to assemble the complete target in little more than an hour.

GIANT AMONG GIANTS

Largest U. S. tank uses Ryan exhaust equipment

LATEST addition to a formidable family of U. S. Army and Marine Corps' tanks is the rugged T-43, a 60-ton monster armed with the largest (120 mm high velocity) gun mounted on an American tank. Like many of today's specialized combat vehicles, it is equipped with Ryan stainless steel exhaust systems.

Designed by Army Ordnance and the Chrysler Corporation, the T-43 is the first heavy tank to be mass produced in this country. Limited quantities for use by the Army and Marine Corps are being built by Chrysler in a new plant at Newark, Delaware, where the General Patton medium tanks have been produced.

The T-43 rounds out the Army's family of tanks, adding the lethal punch of a "heavyweight" to a group which, until now, included only light and medium-gun tanks. Its 120 mm high velocity main armament matches any known tank gun in the world. In addition, a .50 caliber and two .30 caliber machine guns are provided as secondary armament.

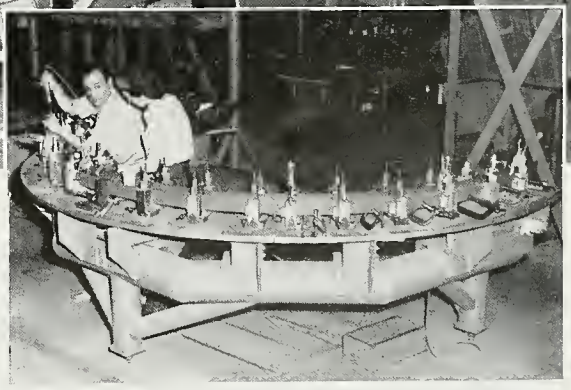
The heavy tank's devastating firepower is made all the more effective by use of a range finder similar to those installed on other recent U. S. tanks. This precision

(Continued on Page 25)

Ryan stainless steel exhaust systems are shown in the process of being installed on the 12 cylinder, 810 hp air-cooled Continental engine at Continental's plant.

Awesome size of the T-43's 120 mm high velocity gun is readily apparent in this striking view of the new tank. Designed by Army Ordnance and Chrysler, the 60-ton T-43 is the first heavy tank to be mass produced in the United States.

NEW WAY . . . Vertical-type fixture for same part requires only 55 square feet of floor space. Ryan estimates space saved is worth $750 a month in gross. Jig rotates to provide maximum access to both sides of part.



OLD WAY . . . Horizontal-type fixture for building large fuselage frame takes 150 square feet of valuable floor space and restricts access.

Through constantly improved methods, Ryan is saving time, space and material in production. These savings provide direct benefits in the form of lower costs for customers and job security for employees. But they are not accomplished through chance.

Like a store, a manufacturer has specific things to sell. These are know-how, manpower and the use of tools. No matter how large or small a company may be, it has a limited

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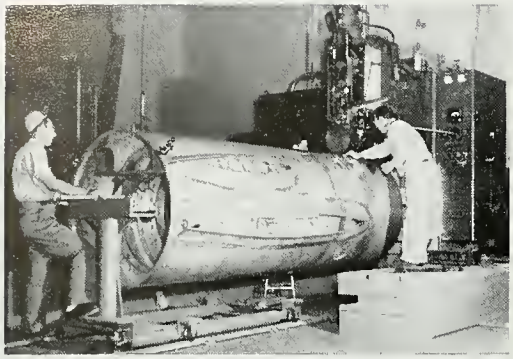
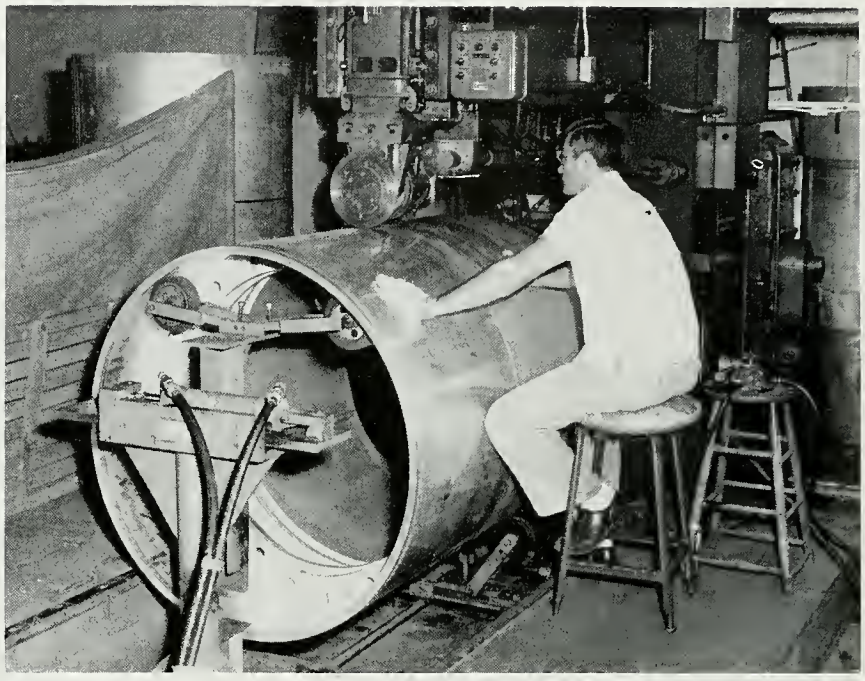
Doing It Better

Better methods begin as employees' ideas which are expressed and put into action



OLD WAY . . . Two men needed to seamweld large Ryan fuel tank. Operator (right) signaled helper to move tank right or left to keep seamweld straight and prevent spiraling weld seam.



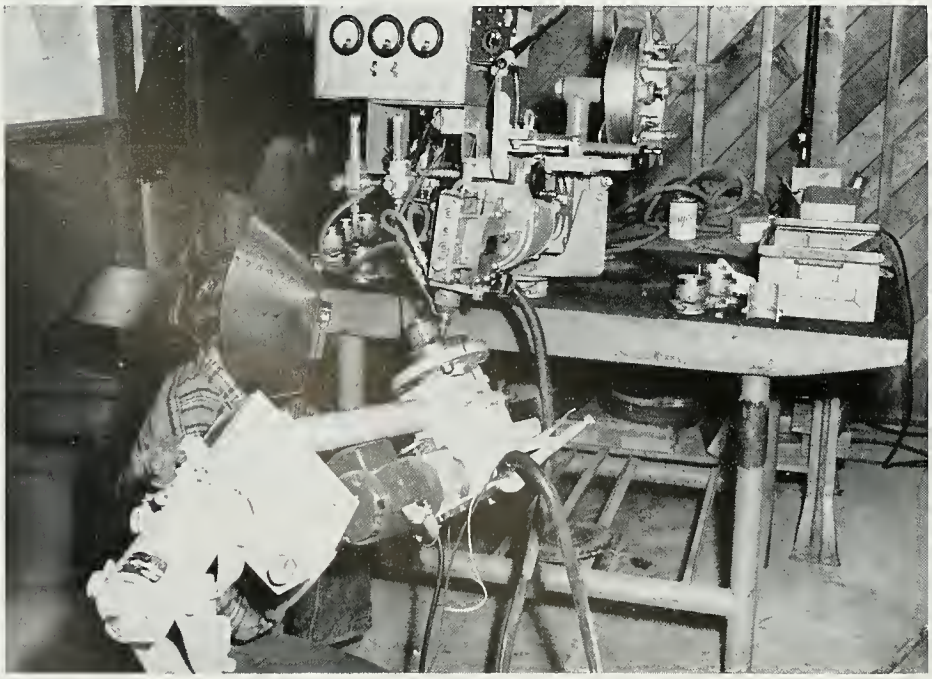
NEW WAY . . . One man does the job. He controls tank alignment with valve temporarily located on stool. This actuates air cylinder mounted on rear of fixture to yaw tank. Even sharply-tapered tank sections are smoothly seamwelded with this simple control system.

supply of these basic requirements. Success hinges upon how well these ingredients are blended into a product of good quality and competitive price.

A square foot of floor space, a sheet of stainless steel and a manhour have one thing in common: they all represent dollars in the cost of the product. For 32 years, Ryan has achieved success by being conscious of this industrial fact. Time, space and materials are conserved through a coordinated program carried on by the Methods Engineering, Production Engineering and production departments.

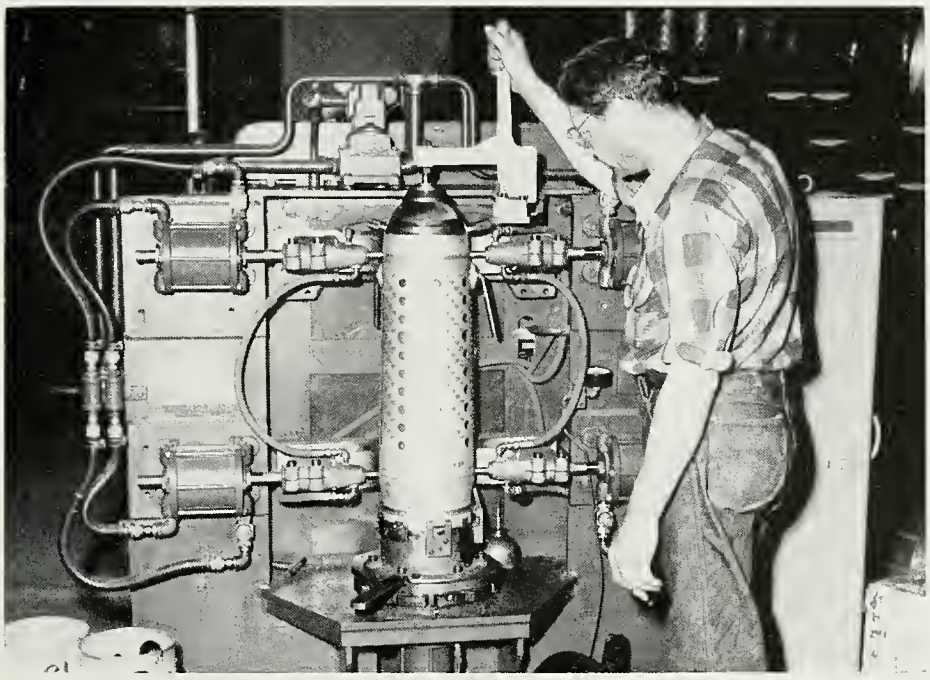
At Ryan, methods engineers are assigned to each production area. They are charged with developing production layouts, recommending new machines and improving methods. They stimulate the flow of new ideas from employees and assist in putting them into effect. They maintain material conservation consciousness in the plant through regularly-scheduled meetings.

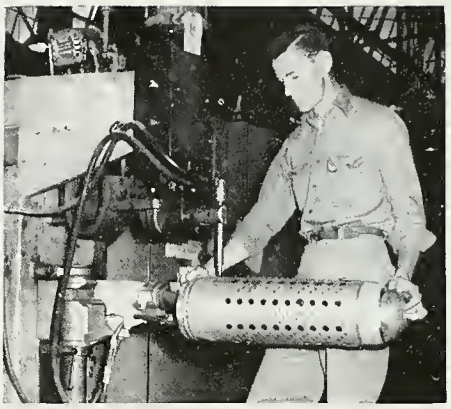
Another group, important to the production picture, are the production engineers. Working closely with methods engineers, they develop the tools and fixtures used to produce every product. Often their ingenuity determines whether



OLD WAY . . . Manual method of arc welding stoinless steel nipples for exhaust system took three minutes, with foot-controlled rotating device plus finishing.

NEW WAY . . . Fast Sigma welding method and special positioner produces a better part in just 7 seconds. The new method eliminates machining and saves Ryon approximately $6000 a month in cost.





OLD WAY . . . Inconel inner combustion chamber is spotwelded with individual spotwelds. Previously, shell, cap and exit body had to be placed in a fixture, aligned and spot tacked together.

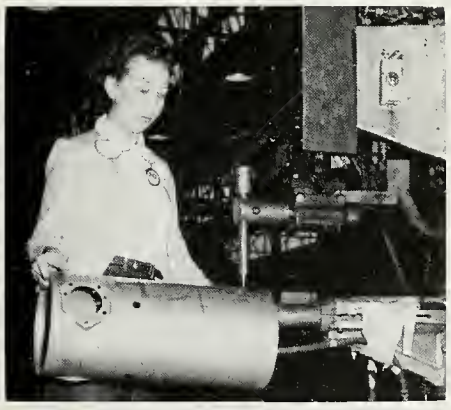
NEW WAY . . . Special machine aligns and spotwelds combustion chamber assembly, making four spotwelds at once. Part is rotated to make 32 spotwelds. Operator is relieved of doing precise, tiring work.

or not a difficult part will be manufactured at a profit or loss.

Last but certainly not least are the production employees themselves. Actually closest to the scene of action, they are the most lucrative source of suggestions on how the work may be improved. Fortunately, Ryan enjoys an atmosphere of enthusiastic teamwork in which supervisors and employees freely express their constructive ideas. Undoubtedly, this active participation is the key to the success of the program.

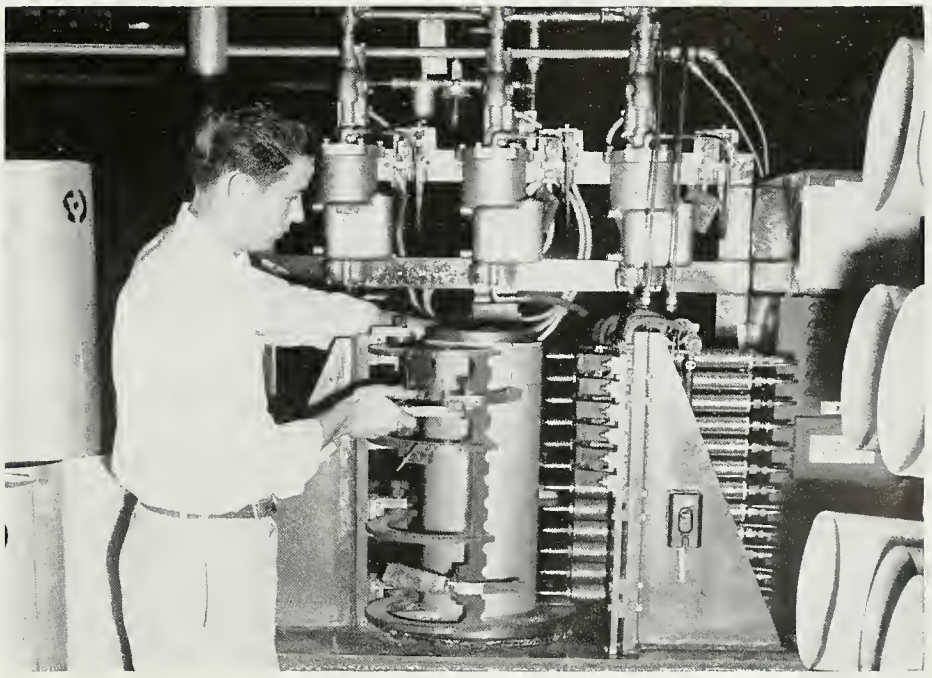
With increased activity in the field of prime contracts, Ryan has expanded its Engineering Division to include producibility engineering. Producibility engineers are concerned with the design of Ryan products. They analyze new designs from a producibility standpoint, determining the best design for meeting personnel, tooling, material and production rate requirements.

Ryan builds a variety of precision products from relatively expensive materials. Product designs change constantly to keep pace with the swift flow of aircraft development. Because of these factors, the rewards for vigilance in production improvements are significant.



OLD WAY . . . Operator held and aligned outer combustion chamber while spotwelding, making one spotweld at a time. Job required skill to hold parts round.

NEW WAY . . . Ryan designed machine makes 12 spotwelds at once with hydraulically operated electrodes. Expanding arbor keeps parts round and reduces rejects by 70 percent. Eliminoting holding reduces fatigue. Parts are kept uniform.



A $55 Thyratron tube is checked in the new tube tester by George Pearson. Tube is vital part af welding machine shown at rear.

TUBE TESTER

Pearson demonstrates the simplicity and compactness of the new tester which he helped design in electrical maintenance.

King-size tubes can't fool this Ryan device

ELECTRICAL maintenance men at Ryan are saving time and trouble with a new tube tester which takes the guesswork out of trouble-shooting. This device is used to test the large Thyratron electronic tubes which are used in all resistance welding machines. At Ryan, where 100 welding machines of this type are in constant use, the tube tester is a valuable tool for pin-pointing tube troubles and reducing machine "down-time" to a minimum.

The instrument was designed by electrical maintenance personnel and fabricated from used, surplus materials. It contains relatively few parts including a transformer, grid circuit, resistors, voltage regulator tube, rectifier, ammeter and voltmeter. The ammeter has been modified to register from zero to 5 amperes. The voltmeter has been altered to register from minus 20 to plus 20 volts.

With the new device, Ryan electricians can check the eight

(Continued on Page 26)

THEY CALL IT DOPPLER

(Continued from Page 3)

he was sitting still. When the fisherman takes to the train, he is leaving the musical instrument faster than ever, and the note sounds as if it originated in a tuba. If the observer were approaching the trumpet, the note would seem to be progressively higher as his speed increased. The same phenomenon occurs with light, but because the speed of light is so much greater than that of sound, nothing on earth moves fast enough to provide us with a commonplace example.

As Doppler suspected, however, the stars are moving so fast that an appreciable color shift might be expected in the light we receive from them. What he did not know was that the light of the stars, rather than being white (i.e., made up of equal amounts of all colors), is actually composed of narrow bands of color emitted by the burning gases within the stars. These bands are characteristic of the chemical elements found in each particular star, and they extend throughout the infrared, visible, and ultraviolet regions of the spectrum. Therefore the apparent color of a star results from the combination of some very specific colors, which can be measured in a spectrograph. Doppler shifts of these specific colors do occur, providing astronomers with valuable data about star velocities, the rate of rotation of the sun and the rings of Saturn, the motion of the solar system among the stars, and the behavior of atmospheric currents in the sun. A star which normally appears white, however, still appears white no matter what its velocity, because the Doppler Effect merely shifts some of the star's visible output into the ultraviolet region (star approaching), and some of its invisible infrared radiation into the visible spectrum.

Aside from astronomy, the greatest beneficiary of Doppler's ideas has been the field of electronics. In electronics applications, neither sound nor light, but rather radio waves, of whose existence Doppler never dreamed, play the leading role. Because of the Doppler Effect, radio waves reflected from a moving object undergo frequency changes proportional to its speed with respect to a radio receiver or transmitter. By measuring these changes it is possible to determine the velocity of moving projectiles in ballistics studies, to locate a moving object among a number of fixed ones for burglar alarm devices, and so on.

If John Tyndall, the English physicist who wrote so disparagingly of Doppler's work, could not forgive his Austrian colleague some fundamental errors, posterity has proved more kind. The errors, in fact, have long been forgotten, but the phenomenon Doppler predicted has become enshrined among the high-school textbooks and the laws of physics, where it justly bears his name.

—Alfred L. Cotcher

Brig. Gen. Floyd B. Wood, right, and John Herold, Ryan weapons system engineer, are glimpsed through opening of jet engine test cell on inspection visit. Man at left is working on exhoust "silencer" odjoining test cell.

Air Force General Flies Own Jet to Ryan from Eastern Base

Brig. Gen. Floyd B. Wood is shown at Ryan plant, stepping out of the T-33 jet plane he flew here from Baltimore. He is Deputy Commander for Technical Operations at Headquarters of Air Research and Development Command.

An Air Force general who flew his own T-33 jet plane across the country visited Ryan recently to bring himself up-to-date on the company's most advanced projects in the airframe, guided missiles and electronics fields.

He is Brig. Gen. Floyd B. Wood, Deputy Commander for Technical Operations at the Headquarters of the Air Research and Development Command in Baltimore. Wood recently was nominated for promotion to Major General. He piloted the T-33 from Baltimore to San Diego in six hours' flying time, making two stops en route.

Although his Ryan schedule was to have been confined only to a forenoon visit, he was so interested in the company's new projects that he remained until mid-afternoon. That night, he addressed the San Diego section of the Institute of Aeronautical Sciences on how the Air Force develops and procures complex weapons systems.

DOING IT THE WRIGHT WAY

(Continued from Page 11)

been noted by pilots in the J-65's superior rate of acceleration and by the absence of the smoke trail common to most jet engines.

Its content of strategic materials is low, involving only small amounts of tungsten and no cobalt or columbium.

Maintenance crews have found that the standard turbine inspection required on all turbojets can be performed considerably faster on the J-65 than on other engines of this type.

The Curtiss-Wright J-65 is a single-spool engine with a 13-stage compressor that efficiently handles large air volumes per square foot of frontal area. The first seven stages comprise the low-pressure section of the compressor and the last six form the high-pressure group.

The diffuser section behind the compressor is integral with the center main bearing support housing. Located about mid-way in the engine, this support is a key part of the engine's structure.

Two trunions attached to this support carry not only the engine's weight but maneuver loads as well. Assembled from two nodular iron castings welded together with ten stainless steel struts, the center support is now being made for about one-fifth the cost of building it to the specifications of the original design. The nodular iron assembly has superior properties, with respect to load and temperature, to the one-piece aluminum support once used.

The J-65 uses an annular combustion chamber equipped with a vaporizing fuel system that results in superior performance at the higher altitudes where fuel flows are smaller. Other turbojets produced in the U. S. have atomizing fuel systems.

Recently it was disclosed that a version of this engine with afterburner, selected for the Grumman F9F-9, is available.

Curtiss-Wright designs and builds every major powerplant type. The company's Turbo Compound, for which Ryan also makes parts (segmented turbine nozzles) is flying in both military and commercial transports and is the fastest piston-type engine on the world's airways. The Turbo Compound has been specified by 25 world airlines for their new transport fleets.

Using exhaust gases to drive three rear-mounted velocity turbines, the Turbo Compound gains an added 20 percent in power from once-wasted exhaust energy and has reached a top rating for military use of 3700 horsepower. The engines used in such commercial planes as the Lockheed Super Constellation and Douglas DC-7 are rated conservatively at 3250 horsepower, although more powerful advanced models are in the offing.

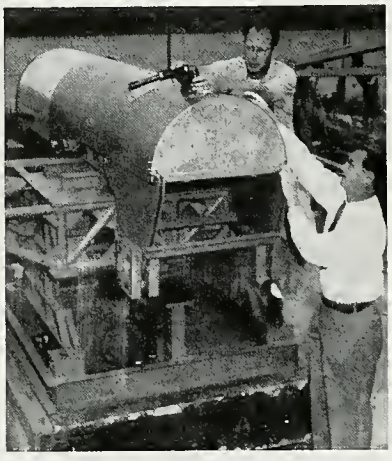
These future engines can bring about the day of 400 mph cruise piston-powered transports.

Tests Performed To Check Structure Of Air Force Firebees

So-called "slosh" tests have been performed to check the structural integrity of fuel tanks of the new Firebees being produced for the Air Force in a $3,500,000 order.

The tests were conducted on a Ryan-owned vibration table used for other tests in the past and altered for its latest function by the engineering department.

To test the integral fuel tank and fuselage structure, the tank was filled to two thirds capacity with a special test fluid. Hydraulic rams in the vibration table rolled the structure fore and aft at angles of 15 degrees continuously for five hours.



Adjusting a vent outlet in "slosh" tests just performed on Firebee structure are left to right, R. H. Lankard, assistant supervisor, engineering laboratory; and R. T. Benesch, Firebee group engineer.

In another type test, to determine if any leaks exist, the tank was filled with the test fluid, and internal pressure of 3 psi was introduced with a hydrostatic column.

Such tests determined whether the fittings were designed properly and whether the structure would stand service requirements. The Firebee is a pilotless jet target drone plane.

Curtiss-Wright has designed or is producing a series of jet, turboprop, ramjet and rocket engines for the higher speed bracket. Including the powerful twin-spool J-67, these power plants cannot be described because of security restrictions.

Curtiss-Wright is also active in other fields, both in and out of aviation. The company's Propeller Division makes electric and turboelectric propellers for airliners and military aircraft, including the vertical take-off fighters and the entire fleet of Naval blimps.

The company's Electronics Division introduced Simulators to achieve a revolution in pilot and crew training and has since been selected to design and build units for the largest U. S. planes, including the Convair B-36 bomber and the huge Douglas C-124 Globemaster. The Electronics Division made one of the early Simulators for jet fighters (the McDonnell 2F9) and is now completing the design of a Simulator for the Boeing B-52 eight-jet bomber. Simulators for other advanced aircraft are also on order.

In addition, Curtiss-Wright has supplied electronic training equipment to both foreign and domestic airlines and has delivered Simulators for the Boeing Stratocruiser, Douglas DC-6B, and Convair 340 passenger transports.

Simulators are all-electronic units built around the actual cockpit of the plane to be reproduced so that flight crews can train together as a team to bring their skills to peak proficiency. Airmen using them say that the Simulator conveys a true sensation of flight, although the unit never moves.

Curtiss-Wright employs close to 30,000 skilled men and women in its ten divisions. The Metals Processing Division at Buffalo, N. Y. produces turbine and compressor blades as well as other parts for making forgings, castings, and extrusions for industry. A new 12,000-ton horizontal extrusion press, largest of its type in the world, is now being installed there.

Marquette Metal Products Co. at Cleveland, Ohio, another Curtiss-Wright division, manufacturers precision clutches, pumps for the petroleum industry, windshield wipers for all types of aircraft, high-quality textile spindles and other products.

In recent years, Curtiss-Wright has entered the plastics field, making products both for the home and for use by industry. And the company's continued expansion is assured with the recent announcement that Curtiss-Wright has acquired, through license by four German and Swiss companies, the rights to produce scientific apparatus in the electronic and ultra-sonic fields.

GIANT AMONG GIANTS

(Continued from Page 18)

optical and mechanical device quickly calculates the distance to the target with a minimum of dependence on the "human element."

Manned by a crew of five, the T-43 can travel at speeds in excess of 20 miles per hour. Simplified handling controls minimize driver fatigue. For example, the T-43 has a steering wheel and a steering-column gear shift similar to those installed in passenger automobiles having automatic transmissions.

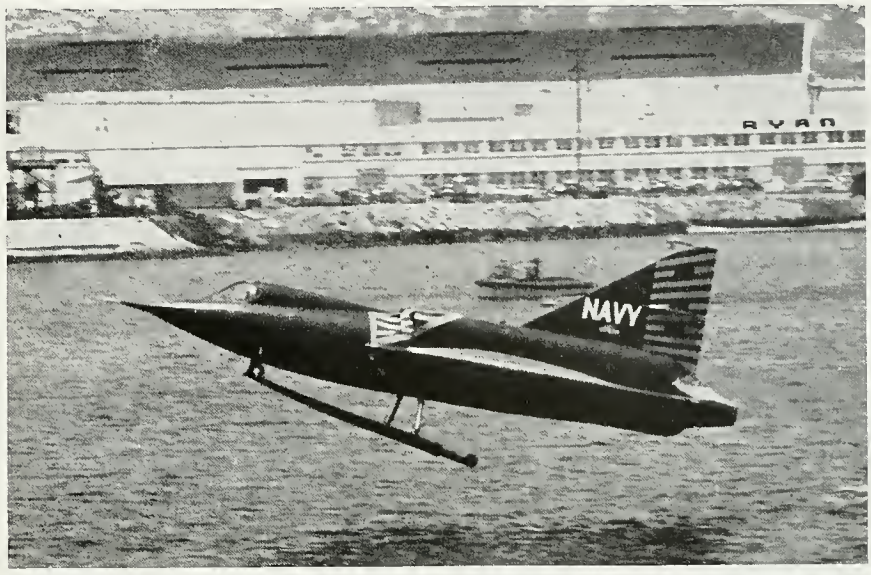
The powerplant is an Ordnance-Continental 12-cylinder, air-cooled, V-type engine rated at 810 horsepower, or 1040 horsepower when supercharged. This, in combination with a cross-drive transmission, engineered by the Allison Division of General Motors, makes up the "power package" which gives the T-43 extreme flexibility of operation, speed and maneuverability. The transmission, working in conjunction with the steering system, makes possible pivot turning on the spot.

The T-43 joins an impressive array of military vehicles for which Ryan exhaust equipment is specified. Others include the T-51 tank retriever, the General Patton M-46, 47, 48 medium tanks, the T18-E1 armored personnel carrier, the LVTH amphibious landing vehicle and the LVTP armored assault vehicle.

All of these combat vehicles, as well as a number of others, are powered by one or another of a series of engines developed by Continental Motors Corporation and the Ordnance Corps. Ranging from 375 to 1040 horsepower, these engines were designed to incorporate a large number of interchangeable parts. This greatly simplifies maintenance and repair operations in the field.

Ryan has been building complete exhaust systems for the largest of these engines on an assembly line basis for more than three years. During this time, thousands of units have flowed from Ryan's continuous conveyor belt line on which the equipment is fabricated.

Long a leader in the design and manufacture of heat- and corrosion-resistant assemblies for powerplants of all types, Ryan has designed and built exhaust systems for a wide variety of applications. In addition to the combat vehicles of Army Ordnance, Ryan equipment serves seven different types of helicopters and seven types of lighter-than-air blimps. Ryan produces 75 percent of the exhaust equipment used on U. S. commercial and military transport planes.



Ryan-built Afterburners Spark Supersonic Sea Dart

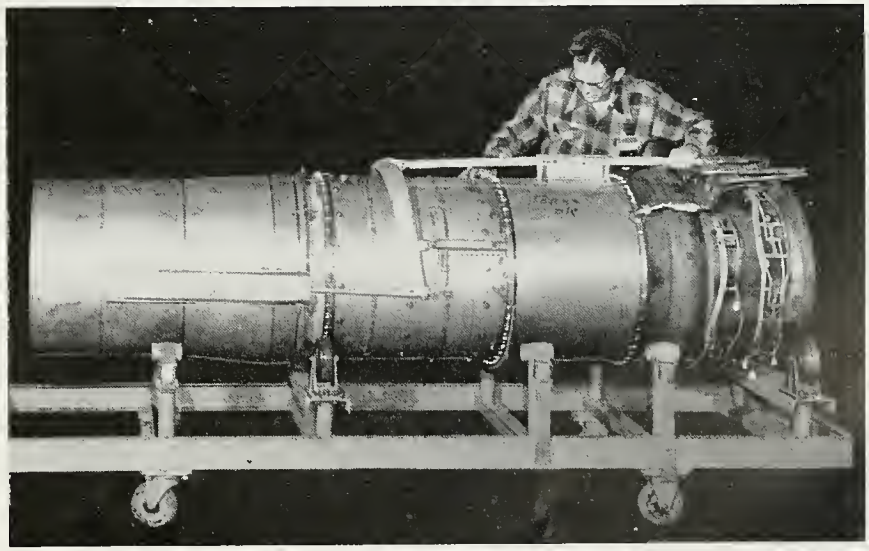
Ryan-built afterburners helped provide the power that enabled Convair's spectacular XF2Y-1 Sea Dart to make its first supersonic flight, recently.

Ryan builds these afterburners for the Westinghouse J-46 jet engines, two of which are now installed in the Sea Dart. In addition to J-46 afterburners, Ryan builds five other types for General Electric, Pratt & Whitney Aircraft Ford Motors and Wright Aeronautical.

After take-off from San Diego bay, Convair Engineering Test Pilot C. E. Richbourg took the Sea Dart to an altitude of 34,000 feet and exceeded the speed of sound in a shallow dive. The flight was a normal operation in the Sea Dart's testing program.

Described as the world's fastest water-based aircraft, the Sea Dart is the first of a new breed of airplanes. Without wheels or floats, it fits into none of the conventional categories and is not an amphibian. On take-off, it planes over the water on its sleek hull, depending upon jet power to gain momentum. As speed increases, retractable hydro-skis extend from the streamlined fuselage and boost the plane into the air. Upon landing, the hydro-skis are again extended to cushion the hull against the impact.

Here is Ryan-built afterburner similar to those installed in Convair Sea Dart, which has made its first supersonic flight, using two Westinghouse J-46 jet engines. James Key, foreman, Department 203, is shown checking nozzle actuating mechanism.



TUBE TESTER

(Continued from Page 22)

types of Thyratron tubes used in welding equipment in the plant, including the 677, 672A, FG17, FG95 and FG57 types. Within a few minutes, the tester will positively indicate the control characteristics of a tube.

Thyratron tubes are the largest and most expensive types used in welding machine control panels. They cost between $8 and $55, depending upon their size and type. Called "trigger tubes" by electricians, they are actually electronic switches which control the large amounts of electricity needed to weld metals. With Thyratron tubes, it is possible to control large voltages, say 3000 volts, with small voltages of only 5 or 10 volts, within accurate limits.

Because tube testers are not available, commercially, for testing these large, specialized tubes, Ryan electricians have had to check them by trial and error methods in the past. A suspected tube in a welding machine was replaced with a new one. If the machine then worked properly, it was assumed that the removed tube was malfunctioning. But it was not thrown away because it might work well in another machine where voltages were slightly different. These tubes are so expensive that it was inadvisable to throw them out because they failed to operate in a particular machine. Therefore, they were accumulated in a storage supply which contained tubes that were either no good or capable of being used in certain machines and not in others.

If the welding machine failed to operate correctly when the Thyratron tube was replaced, then the maintenance man was faced with the question of whether the new tube was good, whether the trouble was elsewhere, or whether both the tube and some other defect were causing the machine's behavior.

Like most electronic tubes, Thyratrons consist of a cathode "gun" which fires a stream of electrons at a target plate. Between the cathode and plate, a grid is interposed and charged with electricity. By impressing the proper voltage on this grid, it is possible to repel the flow of electrons to prevent them from reaching the plate. In this way, a sensitive switch is obtained which allows the current to flow under one condition and cuts it off under another.

To test a Thyratron tube, it is placed in the tester and a voltage of 600 volts is impressed between the cathode and plate. The grid voltage is then varied by means of a potentiometer. Ryan has found that these tubes will operate just as reliably, for test purposes, on 600 volts as they will under actual operating conditions of 2000 volts. Almost all Thyratron tubes used at Ryan will "fire" when the grid voltage is varied between zero and 6 volts. With the tester, it is possible to see exactly where the tube cuts in and off and the voltage at which the tube will "fire" the currents required by the welding machine.

Using the new tester, Ryan electricians have thrown out many Thyratron tubes which were held in storage because of their doubtful quality. Others have been rated so that they may be used in certain machines where conditions are suitable for their operation. Most important, the tube tester permits the immediate qualification of questionable Thyratrons in malfunctioning machines and allows the trouble-shooter to rule out that source of trouble with certainty and dispatch.

DOUGLAS MILESTONE

This might not be the usual way to move an airplane out of a hangar, but it certainly is more interesting. The occasion is the recent roll-out of the 500th airplane in the famous DC-6/7 series at Douglas Aircraft company's Santa Monica plant. Each of the stewardesses, representing airlines from throughout the world, has completed 500 flight hours in the four-engined Douglas airliners. Although the gals didn't actually budge the 150,000 lb. airplane, everybody—including the photographers—enjoyed the attempt.

Since the first DC-6 was delivered in 1946, 38 of the world's leading airlines have chosen the series for their global routes.

"Millions of miles of dependable service over all continents and oceans has gained for this modern, four-engine airliner, the universal admiration and respect won nearly two decades ago by the classic DC-3," President Donald Douglas said at colorful plant ceremonies in which thousands of Douglas employees participated.

Ryan is proud to have contributed to this unexcelled service record through the design and fabrication of DC-6 exhaust systems. Ryan-built DC-6 exhaust equipment was the first ejector-type used with commercial aircraft, in which the thrust of the escaping exhaust gases is used to add extra speed to the airplane's performance.

Undoubtedly, Ryan DC-6 exhaust systems have the distinqnished service record for airline applications. Originally designed for good service for at least one engine overhaul period, these systems have consistently rendered trouble-free service for extended periods of between 4,000 and 5,000 hours.

Ryan is also building substantial quantities of exhaust turbine assemblies which are used to harness exhaust energy in Douglas DC-7 aircraft. The power generated is transmitted back to the propeller to provide the aircraft with a twenty percent increase in range with the same amount of fuel or a fifty percent increase in payload capacity.

TOMORROW'S TANKERS TODAY

(Continued from Page 9)

Boeing's interest in jet transports dates all the way back to 1946 when the company initiated the first design studies. By the time the desired configuration which culminated in the 707 was reached, more than 150 designs had been developed. The actual decision to build the airplane was made in 1952.

During the design program, Boeing consulted all branches of the Air Force concerned with aerial refueling, as well as airlines personnel, pilot groups and the Civil Aeronautics Administration. Many of the suggestions contributed by these groups were incorporated in the new plane. Having taken into account the foreseeable developments, Boeing engineers believe the 707 has the growth potential to incorporate them as they arrive.

The new swept-wing jet is the end result of a well-calculated gamble on Boeing's part—a multimillion dollar gamble that is paying off. With the Stratotanker, Boeing once again has added new strength to America's aerial defenses in a time of critical need.

DESIGNED TO GO PLACES

(Continued from Page 16)

crate along with a dry charged battery.

Designed for limited re-use, the containers are constructed of water resistant plywood. Tops and sides of the fuselage nacelle crate and wing empennage crate are so designed as to be easily removed, leaving the components in open view on the crate bases for ready accessibility and ease in handling during assembly.

Since the containers are often stored in the open, precautions have been taken to protect the Firebee assemblies from the weather. The fuselage-nacelle assembly is enclosed in a moisture-vaporproof container which is heat-sealed on the seams. A humidity indicator is placed in view through a crate inspection door.

The Firebee project was started four years ago as a joint development of the Air Force, Army and Navy, and successful flight testing has been conducted at Holloman Air Development Center on behalf of all three services by the Air Force. Both ground and air launchings have been accomplished.

Ryan is now producing Firebees for the three services, and the high-speed drones are being tested at the Naval Air Missile Test Center, Point Mugu, Calif., as well as at Holloman.

New Equipment Enables Ryan To Do Own Chrome Plating of Rocket Motors

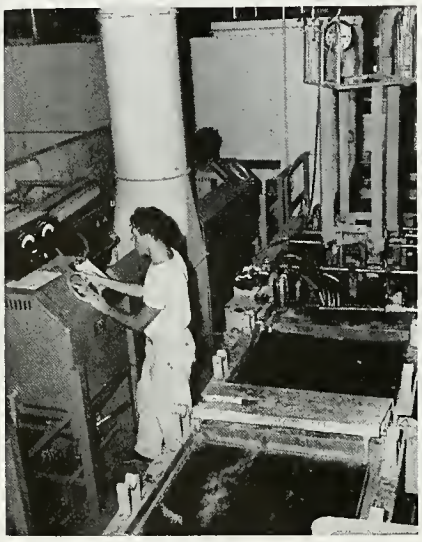
Ryan's aims to become as self-sufficient as possible have been realized in another field in which dependence in the past had to be placed on outside processors.

This is chrome plating, which is now done with recently acquired facilities in the processing department.

Ryan now directly controls the chrome plating of the interiors of rocket engines, on which quantity production has been under way for some time for the surface-to-surface "Corporal" missile manufactured by Firestone Tire & Rubber Company, Los Angeles. The engines are sandblasted, placed in special racks, lifted on a monorail hoist and immersed in a chrome plating bath.

The engines are plated for eight hours in a new high speed chromic acid solution at 120 deg. F. Close watch is kept over the operation to assure a certain thickness of chrome, which with its high melting point (3300 deg. F.) is needed to protect the steel base material from the tremendous heat generated in the short-lived thrust of the engine. Chrome plating also guards against corrosion by chemicals used in the rocket's fuel system.

After the eight-hour plating operation, the engine is rinsed in cold water and then in hot de-ionized water to remove all stains. In event one does not pass inspection, the plating is removed in a stripping tank containing hot caustic soda, followed by a hot-water rinse. Then it is prepared for plating again.



Series of tanks used in chrome plating operation for rocket engines is shown in above photo. Engine is placed in rack for dipping in chromic acid solution. Empty rack is shown suspended from monorail. Ryan-built rocket engine, still classified, cannot be photographed for publication. Operator is Jess Wright.

PLUS POWER

(Continued from Page 15)

porter" for Ryan's varied inspection techniques.)

Three different types of connections are provided in the tube openings. In one is Ryan's famed ball-and-socket joint, in another is a slip joint, and in the third is a flange for a clamp joint.

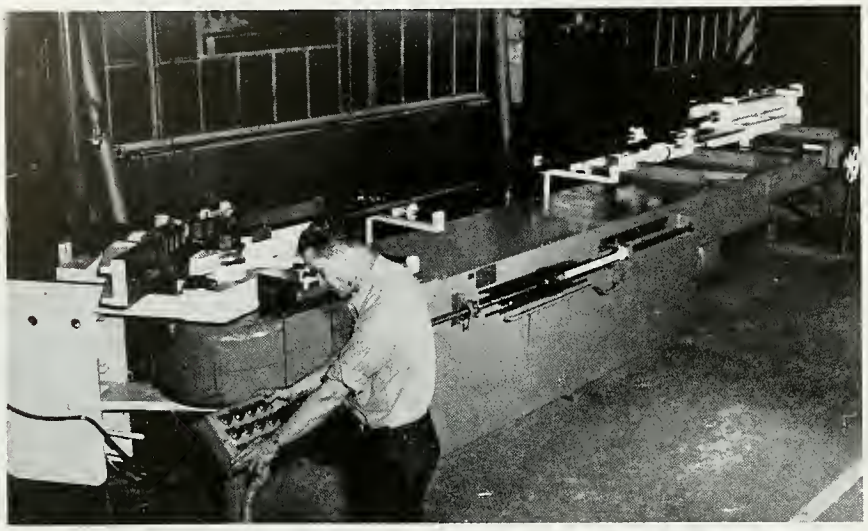
Joining of the nozzle box to the solid machined ring was originally performed by welding. In order to avoid weld stress concentrations, the nozzle box is now bolted to the ring, a change which required a redesign of the Ryan component.

The exhaust gases which enter the nozzle are turned by stator vanes to an angle of 15 degrees from the path of the turbine wheel, resulting in maximum turbine efficiency. After passing through the turbine, the gases are discharged through a turbine hood into the airstream.

Ryan also produces the turbine hood for the Fairchild C-119F Packets. One clamp holds as a unit the hood, the machined ring and the nozzle box, and for the C-119F, Ryan also produces the clamp. Thus, for this plane, the "guidance system" for exhaust gases, both in and out of the turbine wheel, is virtually 100 percent Ryan-produced.

In what has been characterized as the Jet Age, the piston engine has been given a new lease on life with such power plants as the Wright Turbo-Compound. And Ryan, which specializes in producing the means by which tremendously hot gases are most efficiently conveyed in both piston and jet engines, is helping to extend the usefulness of the piston engine through assistance of the gas turbine, an essential feature of the jet engine.

By tapping the heat energy of a piston engine's exhaust, Ryan-built nozzle boxes are channeling plus power for military and commercial aircraft.



Operator Lloyd Roberts controls Ryan's new Pines tube bending machine from a mobile push-button control panel. The ingenious $30,000 machine will play an important part in Ryan's thin wall ducting program.

New Ryan Tube Bender For Thin Wall Ducting

A $30,000 tube bending machine, the most modern of its kind and the largest in the plant, is being used in the Ryan manifold division as one of the key units of machinery employed in volume production of new types of products.

Typical of these developmental projects is the work which Ryan has done with thin wall ducting. This is a technique by which hot, compressed air is piped from jet engines through tubes of stainless steel to provide heat and power for various auxiliary tasks essential to the efficient operation of the plane and the comfort of the crew and passengers.

Preparations are being made to produce such ducting for new jet aircraft which will use a considerable quantity of this weight-saving system for transmitting heat and power. The tube bender, manufactured by the Pines Engineering Co., Inc., Aurora, Ill., was acquired by Ryan as a major step in its long range plans.

For the immediate future, it will be possible to perform in the plant tube-bending on manifold work which has had to be farmed out to outside contractors. This will result in a substantial saving in production costs.

The new Pines machine makes possible highly accurate, wrinkle-proof bending of extremely thin material. The precise bends are performed with adjustments effected by electrical and hydraulic controls of the latest design.

METAL SLEUTHS

(Continued from Page 13)

to be examined. After passing through the part they impinge upon a photographic plate or film and affect its emulsion.

Some of the X-ray radiation is absorbed by the metal through which it passes and this absorption is proportional to the density of the alloy. Consequently, all types of concealed discontinuities in the metal will show up as variations in the effects which the rays have upon the photographic emulsion. Hidden welding defects, such as gas pockets, cavities, porosity, shrinkage cracks and so on will appear as darkened areas on the film because they permit greater amounts of radiation to pass. Inclusions, such as slag, oxides, foreign material and other bodies may show up as darker or lighter areas depending upon the density of the surrounding metal.

By stepping up the power of the cathode "gun" which fires the electrons and thus releases the X-rays, it is possible to produce more powerful X-rays with greater penetrative properties. Ryan's largest machine employs a tube which has a maximum output of 250,000 volts at 10 milliamperes. With this power it is possible to shoot X-ray photographs (radiographs) through four-and-a-half inches of steel.

Ryan inspectors subject all fusion welds on such vital components as Pratt and Whitney Aircraft J-57 jet engines, Westinghouse J-46 afterburners and Boeing B-52 structural members to X-ray inspection. In addition, X-rays are used to search out the tiniest defects in a wide variety of castings, forgings, welded tanks rings and other components whose soundness must be completely assured.

FLUORESCENT PENETRANT

Another technique employed at Ryan to detect imperfections in metal parts is fluorescent penetrant inspection. This is a sensitive, non-destructive method for finding minute cracks, pores and discontinuities in all types of metal. Its use is limited to those imperfections which extend to the surface. But, in this respect it is more effective than X-ray inspection which will not disclose extremely small surface cracks.

In the procedure the parts to be examined are coated with an oil-base, water-emulsifiable penetrant by dipping, brushing or spraying. The penetrant contains a mixture of fluorescent particles which will glow brilliantly under ultra violet light. The parts are allowed to stand for approximately 30 minutes to permit the penetrant to seep into all fissures and drain from the surfaces. Then, they are washed with a water spray which removes excess penetrant.

While still wet, the parts are sprayed with a developer compound which consists of a colloidal suspension of powdery materials. The developer is dried by placing the parts in an oven for five minutes. As the developer dries, it draws the fluorescent penetrant from the crevasses to the surface by capillary attraction. By viewing the parts in a "black light" booth the exuded particles may be observed to glow with a fluorescent brilliance under the ultra violet radiation.

The exact pattern and location of each defect is vividly displayed by the glowing particles. The depth of the defect may be estimated by the amount of penetrant which emerges from the fissure.

Penetrants with exceptionally good properties of surface tension, and viscosity can reveal surface cracks in non-porous materials which are only a few millionths of an inch in size. Because the method requires various types of equipment, fluorescent penetrant inspection at Ryan is accomplished on a conveyor system which carries the parts through the application, washing, drying and viewing operations.

Fluorescent penetrant possesses a particular advantage for parts which are to be reworked at a later time. The fluorescent particles remain permanently in the metal cracks so that once treated, a part may be inspected many times after that by simply subjecting it to ultra violet light.

(Continued on Next Page)

DYE PENETRANT

The dye penetrant inspection method is a simplified version of fluorescent penetrant. It, too, is a mechanical method of detection which is extremely efficient in locating defects that extend to the surface. It requires an absolute minimum of equipment which can be readily carried by an inspector. Consequently, it is valuable as a means for inspecting in the field and for checking large immobile structures which cannot be handled by other methods.

The only equipment needed are quantities of dye penetrant, solvent and developer compound and three brushes. Parts must be cleaned free of all oil and grease before examination. The penetrant, which is a low-viscosity, high capillarity fluid containing a red dye, is applied to the surface. This can be done by brushing, spraying or dipping. Five to fifteen minutes is allowed to permit the penetrant to soak into surface imperfections. Then, all penetrant is removed from the surface by washing them with solvent. When the parts are dry, the developer is brushed, sprayed or dipped on in a very thin coating.

Capillary attraction exerted by the developer will draw quantities of the red dye from any cracks or fissures existing in the metal. These will become readily apparent by contrast against the white background of the developer film, showing the location and extent of each defect.

Unlike fluorescent penetrants, when the dye penetrant indication is removed, the part will not show another indication of the defect without another treatment. Dye penetrants are exceptionally convenient for checking parts in use, such as aircraft propeller hubs and landing gear, without going to the trouble of disassembling them.

Because dye and fluorescent penetrants are similarly reliable for detecting the smallest blemishes and cracks in all types of metals, Ryan employs one or the other method for examining components. Then, X-ray is used to reveal the hidden imperfections which lie below the surface.

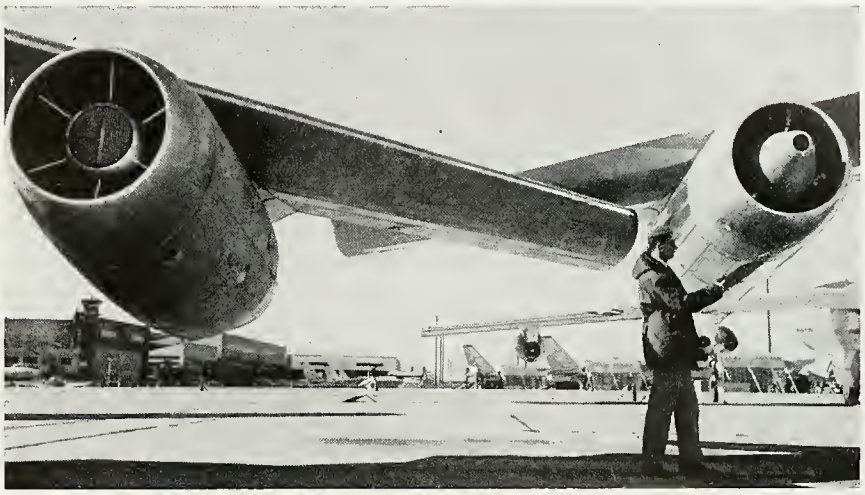
MAGNETIC PARTICLE

If the parts are made from magnetic alloys, Ryan usually uses magnetic particle inspection to find surface defects, rather than the penetrant methods, because it requires less time. This non-destructive technique is applicable to all sizes and shapes of parts. It possesses many production advantages because of its speed. Parts can be checked by simply dashing them in oil and examining them immediately without waiting for drying or processing periods. The method saves proportionately greater amounts of time when a large number of small parts are to be inspected because of the numerous manual operations which are eliminated.

For magnetic particle inspection, the parts are dipped or sprayed with a thin oil which contains iron oxide or other particles which will respond to a magnetic field. Then they are magnetized by either placing them in a solenoid, excited by an electric current, or passing a magnetizing current through them. In either case, finely divided iron oxide particles will adhere to any surface defect, showing its pattern and location.

This phenomenon is due to the fact that cracks, breaks or spaces in the metal structure present a pathway of reduced magnetic permeability which is less permeable than the surrounding metal. This causes the magnetic field generated to "bow out" and pass around the discontinuity. When the break extends to the surface, the magnetic lines of force "leak" out and form magnetic poles which attract the iron oxide particles. If the break lies just below the surface, some magnetic flux may still be deflected to the surface to provide a visible indication of the defect. If the discontinuity lies deeper, the flux may find a pathway within the metal without leaking through the surface and no indication would occur.

(Continued on Next Page)



BOEING STRATOJETS SHAKE-DOWN J-57's

It's a good bet that two of the more than 700 Boeing B-47 jet bombers produced can "show their heels" to the rest of the fleet in any climb for altitude or race for speed. These are the two Stratojets which have been equipped with Pratt and Whitney Aircraft J-57 engines in place of the standard General Electric J-47 turbojets carried on their outboard engine mounts.

The "souped up" models now pack an additional 10,000 pounds of thrust or one-third more power. They should be able to climb like rockets and pull away from other B-47's like unleashed greyhounds.

However, the planes were not modified to thrill pilots. Accomplished by Boeing's Wichita plant, the specially equipped bombers are being used as part of the Boeing B-52 Stratofortress test program. With an exhaustive high-altitude test program now under way, it was determined that it was more economical to mount the J-57 engines for special tests on B-47s than to utilize one of the eight-engined B-52 prototypes.

A comparatively simple job, the modification of the Stratojets included placing the more powerful J-57 engines at the outboard engine locations only. The aircrafts' two double pods, each containing a pair of General Electric J-47 engines, were retained in their inboard locations.

A substantial number of vital components for both types of power plants have been supplied by Ryan. For the J-47, Ryan has built thousands of combustion chambers, transition liners, exhaust cone assemblies, aft frames and afterburners. For the newer J-57, Ryan is an important producer of 30 different high temperature structures for both power plant and afterburner. These are fabricated for Pratt and Whitney Aircraft—the J-57 designer—as well as the Ford Motor Company—who are licensed to build the engine as prime contractors to the Air Force.

All of these methods of inspection—X-ray, fluorescent and dye penetrants and magnetic particle—have two characteristics in common. They are non-destructive in effect, thus lending themselves to the examination of finely finished parts. And, they are employed to detect defects or foreign materials existing in the metal structure or placed there by fabrication processes.

Ryan uses another interesting inspection device which does not fall into these categories. This method is spectroscopy and it is supervised by the engineering laboratory. Spectroscopic examinations are employed to determine the formulae of the metals which Ryan receives for production. While it is not a non-destructive method, the few grains of metal consumed by its use are negligible.

SPECTROSCOPY

Metal samples from stocks of raw materials are sent by Ryan's receiving department to the engineering laboratory for spectrographic analysis. Similarly, all parts which Ryan vendors supply are checked to determine that their formulae meet the engineering specifications delineated.

A tiny sample of metal or a complete part may be analyzed with the spectrograph. This useful machine generates an electric spark between two carbon electrodes which vaporizes a very small amount of metal tested. As the metal incandesces, the light emitted is passed through a slit, to limit its height and width, and directed to a diffraction grating. This is a polished concave surface upon which are ruled 48,000 parallel lines within two inches. The grating reflects the light to a strip of film, breaking it into its various wave lengths like a prism does.

The light exposes the film in a series of light and dark bands, depending upon the wave lengths present. This picture, called a spectrogram, is taken to a densitometer and viewed in magnified proportions on a ground glass screen. Here, the pattern is checked against a standard which indicates which light waves are present. By comparisons with master spectra, it is possible to tell exactly which elements are present in the original metal sample. Often, traces as small as 1/1000th of one percent are detected, which could not be disclosed by other means. By comparing the intensities of the spectrum bands with standards it is also possible to make a good determination of the amounts of each element present. If exact amounts are required, a further examination of the sample is made through wet chemical methods which provide exact quantitative analysis.

X-RAY METALLOGRAPHY

Although X-rays were discovered in 1895, their true nature was not known for many years. As they have become better understood, they have opened new vistas of approach for metallurgists. Previously, the principal tools for metallurgy were the microscope and spectrograph. Both depend upon the optical properties of visible light and have a resolving power limited by the wave length of light.

X-rays, with much shorter wave lengths, offered a new potential but could not be harnessed for probing matter because of the lack of a suitable diffractive mechanism. Optical diffraction gratings had spacings which were much too wide, yet were as fine as human hands could make them. Then, the idea of using the actual spaces between the atoms in a solid body was conceived.

It had been known that atoms in solid bodies were arranged in neat crystalline patterns with spacings that were close to the wave lengths of X-rays. Experiments were conducted in which X-rays were projected through crystals and directed to photographic plates. They were eminently successful in showing that X-rays could be diffracted by this means and also in substantiating that atoms were arrayed in precise space lattices. The diffracted X-rays bounced off the crystals in a definite direction and intensity which could be measured by the proper instruments.

From these investigations, X-ray metallography has been born. Metallurgists can now examine crystalline bodies with diffracted X-rays and tell a great deal about their physical structure and molecular architecture. For instance, it is possible to determine whether the crystals are cubic, hexagonal or tetrahexagonal, whether heat treatment has caused structural changes and whether more than one phase is present.

By bombarding a metal sample with X-rays of specific wave length, a fluorescent spectrum will be emitted by the test sample. Each wave length in the spectrum corresponds to an element in the sample, just as it did when light waves were used with the optical spectrograph. Intensity of the wave lengths can be measured by a Geiger counter to determine the amounts of the elements present.

With a resolving power of several hundred times that of light waves, X-rays are giving the metallurgist new fundamental knowledge of matter which the microscope is incapable of divulging.

Rare Machine In Receiving Inspection

One of the rarest machines of its kind ever made is now in use in Ryan receiving inspection.

It's a Brinell hardness testing machine, which is believed to have been one of only six of its size manufactured in World War II by the Steel City Testing Machines, Inc., of Detroit, to test the hardness of armor plate. Not only is it rare, but it is believed to be the largest of its kind.

Until Ryan representatives spotted it in an Air Force tool surplus warehouse in Omaha recently, the company had to send to outside contractors large forgings and rings for inspection to determine whether the material complied with specifications regarding tensile strength.

Another hardness testing machine, a Rockwell, in receiving inspection, was capable of accommodating only small machined parts.

When the Brinell was discovered, it was shipped here for heavy duty work on material used in jet engines. It can accommodate rings of up to 22 inches radius and unlike other hardness testers, can be employed for checking un-machined parts.

All wrought material, including bar stock and steel stock, as well as forgings, can now be inspected in the plant on the Brinell hardness testing machine. Parts as thin as .075 inch, as thick as 16 inches, and up to 500 pounds in weight can be handled.

Brinell hardness testing machine, on which L. C. Huffstutter, supervisor, receiving inspection, is checking 300-pound forged ring, is contrasted with Rockwell hardness tester, in which Ralph McKay, machine parts inspector, is examining a small machined part.

AT YOUR SERVICE

(Continued from Page 2)

The vast midwestern region is the assignment of Roderick L. Zorn, a World War II Marine pilot, whose headquarters at Dayton, O. serve as a springboard for service to Ryan customers in Ohio, Michigan, Indiana, Illinois and as far east as Buffalo, New York.

A Kansas City office was activated this year to accommodate Ryan's growing midwestern business, and Thomas D. Lyne services customers there, as well as in Chicago, Wichita, Kan., and Tulsa, Okla.

Wayne Stevenson uses the Ryan plant in San Diego as his headquarters for covering the southwestern United States —Arizona, New Mexico and Texas—and California outside the jurisdiction of the Los Angeles area office.

When a field representative receives a request from a Ryan customer to provide price quotations, he relays the information to Jack Zippwald, customer service superintendent, who has been with Ryan for 16 years. He makes sure that all the necessary data is on hand to enable Ryan to bid. This would include not only the quantity, delivery schedules, and design details, but also the possible volume of future business behind the original order. With all this information knitted together, the quotation request goes to contract estimating, is later formalized in customer service and sent either directly to the customer or to the field representative.

When the order is received, that project is assigned to one of Ryan's four customer service coordinators. From that time on, all correspondence and dealings relating to the order are carried on between the customer and the coordinator.

The coordinator may be considered the customer's representative in the Ryan plant, and at the same time the company's plant representative dealing with the customer. He expedites deliveries, and keeps pace with engineering and schedule changes. He spends considerable time on the factory floor keeping close tab on the progress of a job. He is constantly at the beck and call of the customer. He is the link between the customer and the plant, the man who hears the problems of both buyer and seller and seeks to reconcile them.

Ryan's coordinators, well known by name and voice to the company's customers, are James H. C. Borders, Jr., Byron H. Geer, Rex Smith, and Joseph J. Richert, who also doubles as office manager of the customer service department.

Geer, with 14 years' Ryan service, and Richert, an 11-year employee, are the veterans of this group.

L. L. Underwood is chief coordinator —a sort of "coordinator of coordinators" who assigns the duties to the men under him. Behind him is a background of more than twenty years as an office executive, including key posts with several Federal agencies before joining the Ryan organization in 1942. He is past president of the San Diego Chapter, National Office Management Association.

By telephone, telegraph and letter, the coordinators are in continuous touch with their customers. On "hot" projects, as many as three or four long distance calls daily may be received from a single customer across the country.

After the work is fabricated and in service, the user has at his command Ryan's field service representatives, who assist in solving maintenance and installation problems. They are C. L. Foushee, Jr., the service department manager, a 15-year Ryan veteran, who specializes in commercial airline equipment, and Gilbert M. Hansen, who gives advice primarily to military users of such parts as Ryan exhaust systems and jet engine components. At virtually a moment's notice, they are ready to fly to any part of the United States, and often overseas or to Alaska.

The customer service department's attorney, who makes sure that all sales orders are drawn up in correct legal form, is Reynolds Winters.

The entire operation is directed by Sam C. Breder, customer service director, who is one of Uncle Sam's "early birds," and is the tenth oldest employee in point of service with Ryan.

Breder joined the Army Air Corps almost 40 years ago and served with a Handley Page squadron in World War I. He was first employed by Ryan as sales manager in 1927, the year the "Spirit of St. Louis" was built for Lindbergh. In 1936, he returned to the company and has been its sales manager and customer service director ever since.

"Customer service is an operation that depends entirely on close team work and integration of effort for its success," Breder explains.

"At Ryan we have built up a close relationship with all other departments in the plant to keep new orders, the life blood of the company, moving efficiently. The customer must be satisfied, and we pattern our entire activity around that concept."

Powerful New Truck Tows Giant Planes

New tow truck is shown operated by Jim Burney, assistant supervisor, development laboratory, who is custodian of aircraft used in Ryan electronics equipment testing program. Vehicle can pull such heavy planes as Lockheed P2V, shown in photo, and can produce enough power in a generator to start aircraft engines.

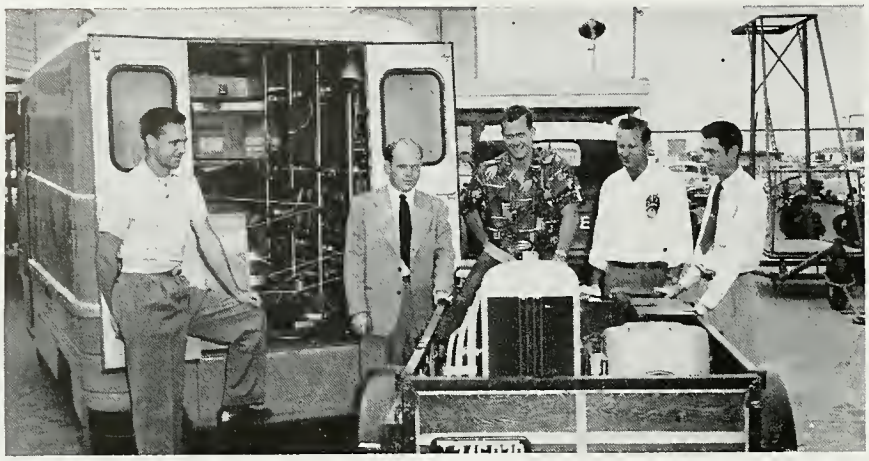
Ryan has had to go into the "trucking business" because of its constant use of large planes for testing electronic developments of the engineering division.

A high-powered tow truck, capable of pulling the largest jet planes made, as well as such huge piston-engine aircraft as the two-engined Lockheed P2V Neptune, has been acquired.

The truck, powered with a 185 h.p. engine, is governed to operate three miles an hour in low gear and up to 15 miles an hour in high gear.

It is also a mobile power unit, the motor driving a generator that will produce 1300 amps for three minutes, enough power to start any jet engine in service today.

The truck thus performs double-duty—towing loads of more than 25 tons, when required, and providing the power to start aircraft engines.



Ryan electronics engineers are shown on their return from recent three-week mission in broiling sun at Edwards Air Force Base, where air temperatures rose to 120 degrees, and surface temperature on Muroc Dry Lake bed was recorded at 144 degrees. Left to right, with special truck containing testing apparatus and trailer with control panel and two generators are, Donald Trumbo, Dave Murphy, group leader; Fielding Hedges, Norman Seely and Robert Peasley.

Ryan 'Foreign Legion' Back From Another Expedition to Desert

Ryan's "Foreign Legion" has returned from another expedition to the desert.

The "Legion" consists of a group of electronic engineers who withstood the searing heat of Edwards Air Force Base, Muroc for three weeks while making special tests of several radar systems being developed by Ryan for the Air Force.

Their testing base is a mobile laboratory, a specially equipped truck packed with electronic test instruments, operated in conjunction with aircraft provided by the Air Force to serve as radar targets.

A large group of Air Force personnel joined the Ryan engineers in conducting tests of the advanced new equipment, details of which are confidential.

The field test crew was headed by Dave Murphy, group leader, and included Fielding Hedges, Robert Peasley, Norman Seely, and Donald Trumbo, electronics engineers. Albert J. Paradise and Dan A. McDiarmid of plant protection guarded the equipment.

W. R. Mauseth, assistant chief of the electronics section, and E. T. Phillips, systems engineer, observed the testing and assisted in the operation.

JET MUFFLER

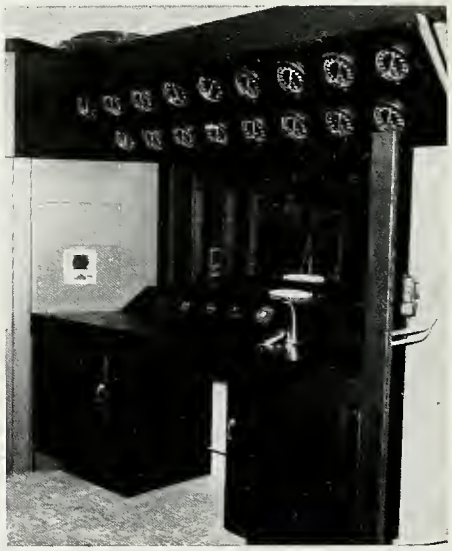
(Continued from Page 5)

forms. In air, sound travels at the rate of 762 miles an hour or 1100 feet per second. When sound waves encounter a different medium, from that in which they are traveling, some of their energy is reflected, some is transmitted and the rest is absorbed in the form of heat. In this respect, sound waves act like light waves striking a glass panel where some of the light is reflected, some is transmitted and the balance is absorbed in the form of heat. When light strikes a completely black piece of velvet, all of the energy is absorbed. The objective of sound silencing systems is to absorb as much of the sound wave energy as possible within the costs allocated.

When sound waves strike the ear, they set the ear drum in vibration and part of the sound energy is converted into mechanical energy. The human ear can distinguish the pitch (determined by sound wave frequencies), loudness (determined by wave intensity) and tone (determined by the wave shapes) of sounds. The ear is sensitive to an enormous range of sound running from 20 to 20,000 vibrations per second in frequency and from a whisper to a thunderclap in loudness.

Engineers measure the intensity of sound waves with "decibel" ratings, which are a measure of the amount of energy which the sound waves are transmitting. However, decibels will not provide the total answer to the annoyance factor of sound because human beings interpret sound waves in different ways depending upon the frequencies encountered and their psychological responses.

In the new Ryan jet engine test cell, Industrial Sound Control engineers have reduced the sound intensity of an operating jet engine from 150 decibels to approximately one half in most frequency ranges. At first glance, this might convey the impression that the noise heard outside the test cell would merely be cut in half. This is far from the case. An employee working outside the structure will experience only one 1/100th of the noise sensation which he would suffer if he were the same distance from the engine and no silencing were provided. To accomplish this, the silencing equipment must drain off more than 99 percent of the acoustic energy.



Behind multiple sheets of bullet-proof glass, Ryan engineers will control and observe two test stands in the cell.

As a result, it will be possible for employees near the test cell to talk in normal tones of conversation and the general noise level will be about that prevailing in the average factory or machine shop. Without such silencing, the jet engine noise would create a sound intensity of 150 decibels which is more than simply too loud. This high level of noise is beyond the listening level and within the area where pain or damage to the ear could be experienced.

THE ENGINE GOES ROUND AND ROUND

(Continued from Page 6)

Its military missions, besides training, might include such functions as command liaison, wire laying, reconnaissance, aerial photography, and other tasks which are now performed by jeeps.

Six years ago, after the Hiller 360 was certified and had gone into quantity production to become the most widely used commercial helicopter in the country, Hiller engineers determined that the answer to low cost and simplicity of construction was in tip-powered rotor blades. This would permit elimination of transmission systems, piston-driven engines with moving parts, and other complex mechanisms required for conventional power plants and drive systems.

Jet engines were obviously the type for such use, and after a long period of experimentation, the ram jet was chosen as the simplest and most suitable.

The first Hiller Hornet was flown in 1950, representing a major step forward in helicopter design. Two years later, the Army and Navy ordered an evaluation quantity. Hiller engineers believe the tip-powered system will be adapted to both large and small helicopters of the future.

Production of the Hiller-designed ram jet engine has proved a challenge, particularly in the welding techniques. Because of Ryan's long experience in this field, and its extensive welding facilities —considered one of the best in the nation—Hiller enlisted Ryan's assistance in the assembly of the first units of this engine. Ryan's work with corrosion-resistant steel and in high temperature applications, as well as its extensive output of components for America's leading jet engines, proved a valuable foundation in tackling this new problem.

The Hiller Hornet power plant is made of Inconel X, a high-nickel alloy. This heat-treatable material exhibits low ductility over certain temperature ranges which may cause cracking during processing. In addition, the external forces on the engine are substantial. There is a great deal of pulsating vibration, plus a high load on the tab, (the connection between the engine shell and the rotor tip) as it rotates at a high rate of speed. These forces, and the nature of the metal itself make the welds extremely critical.

There are six major heliarc welds in the shell, and a sigma weld on the tab attachment to the shell.

Before assembly, each detail part is annealed at 1980 deg. F for 10 to 15 minutes. When the complete unit is assembled, each weld undergoes a thorough X-ray inspection to make sure that no cracks have developed. The unit is then annealed again at 1980 deg. F for 10 to 15 minutes. After ceramic coating, it is age-hardened in a Ryan furnace at 1300 deg. F for 20 hours to bring the unit up to high tensile strength.

Great care must be taken in the assembly of the tab to the shell. The center of gravity of the engine shell must be accurately located with relation to the tab. A deviation could cause flutter on the top rotor.

Location of the tab is accomplished in a fixture with a finely graduated weight scale and two pointer arms. The engine floats free in the fixture, and its weight is carefully calibrated in the instrument until perfect balance is achieved.

Application of the sigma weld technique was adapted in Ryan's welding laboratory for use in the tab attachment to the shell to take advantage of its high speed and deeper penetration into the shell than is possible with heliarc welding. The sigma welding (in which a consumable electrode is used) requires only 20 seconds for each side, after which the edges are finished off with heliarc welding.

Inside the shell is a flame holder, a flat plate from which arms extend radially and are riveted to the shell forward of the blade attachment tab. The fuel is forced through the flameholder under pressure, diffused into fine particles and fired. The only other principal parts are a tiny spark plug to ignite the fuel, and the fuel and ignition lines.

The power units are fastened to the rotor blades by two flush bolts easily removed by a G. I. with no mechanical training.

Although Inconel X has high temperature resistance, it is subject to corrosion from the lead in the automotive gasoline used as fuel. Hence, the requirement that the interior of the shell be given a ceramic coating, which is applied by Ryan-Cameo.

Fuel is stored in tanks under the seat, and is delivered to the rotor head by a rotary pump which develops betweeen 25 and 40 p.s.i.

First models of the Hiller Hornet used a tricycle landing gear and a rudder in place of the conventional tail rotor. The evaluation versions being built for the Army and Navy use a skid-type landing gear and a tail rotor. The skids provide improved landing stability, a factor of proportionately greater importance in a helicopter with a comparatively high center of gravity resulting from placement of the power plants on the rotor tips.

Although the present Hiller Hornets are not quite as simple as the pioneer models because of the addition of the tail rotor, this installation increases stability, particularly when landing at low speed or hovering in cross winds. The tail rotor has a single blade with a counterweight, saving weight and simplifying the control system. It is driven by a belt from the gear box which provides power for the fuel pumps and magneto by means of a drive shaft from the main rotor. The starter drive unit is also incorporated in the gear box. The starter can be manually operated, although an auxiliary power starter is provided.

At a time when aircraft power plants are attaining huge size the Hiller Ramjet engine is Lilliputian by contrast. But it is no less impressive for the fact that it can be cradled in a man's arms. This engine that goes round and round represents an intriguing new concept in the use of jet power.

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ON THE COVER

Using a huge Ryan-designed expanding mandrel, Ryan employees Edward Freeman (left) and Lewis Tipton (right) form corrugations in an afterburner nozzle duct as Foreman Jack Billings checks. Machine can exert 4800 tons of radial force to form Inconel W jet parts.

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RYAN FIREBEE

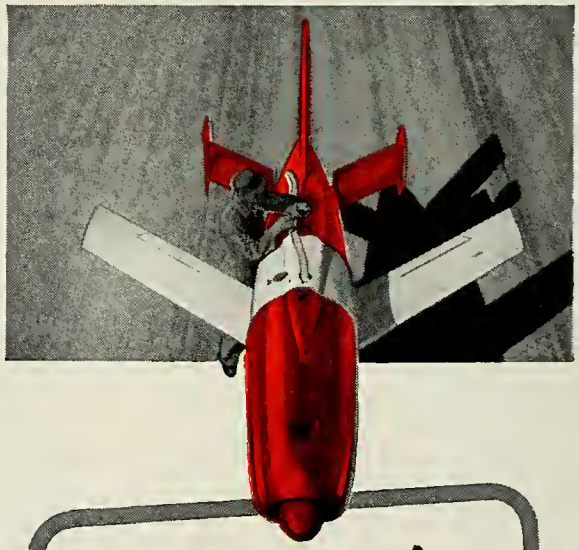
...it lives fast and dangerously!

To keep our air and ground defenders' shooting sharp is the job of the Firebee, America's new high-performance pilotless jet plane. A product of Ryan Aeronautical Company's advanced aeronautical engineering, the Firebee was developed as a joint project of the U. S. Air Force, Army and Navy. It is now being manufactured for use by all three services.

The Firebee carries no human pilot, yet this remote-controlled target plane has phenomenal performance like a modern fighter. It is launched either from the ground or from a "mother" plane and is recoverable by a highly efficient parachute system that lowers it gently to the ground.

Design and development of the Firebee demanded the highest level of scientific talent and technical ability—in the aerodynamic, structural, mechanical, metallurgical and electronics fields. In this latest proud accomplishment, Ryan drew on rich experience gained through its 31 years in the forefront of aeronautical progress.

Because Ryan is *specialized, ingenious* and *versatile* . . . because it is an integrated company with superior abilities in many specialized fields, Ryan is better prepared to accomplish the unique, difficult technical engineering and production assignments of today's high-speed air age.



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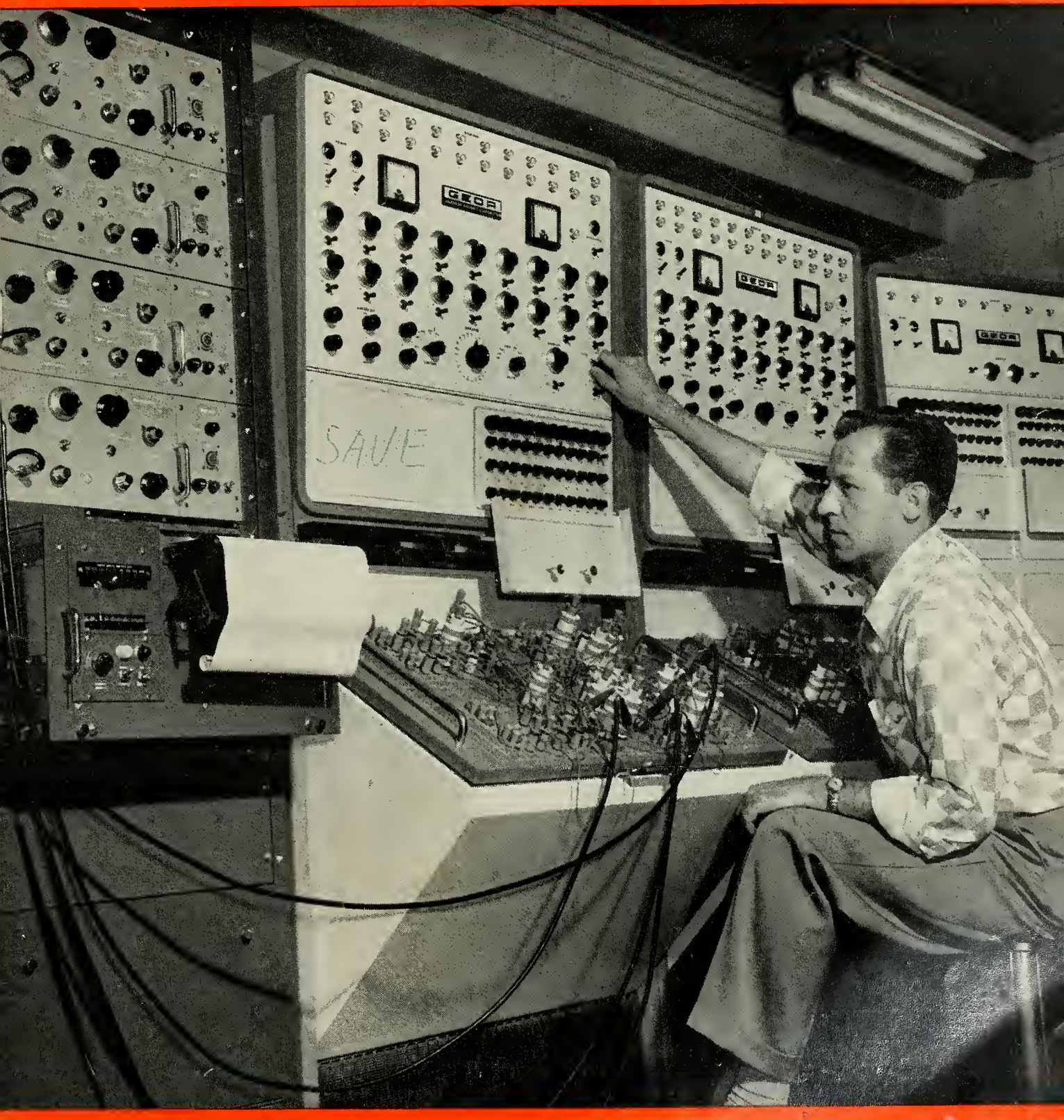
Metallurgical Engineering
Thin-Wall Ducting
Firebee Pilotless Jet Planes

Pioneers in Each ★ Leaders in All

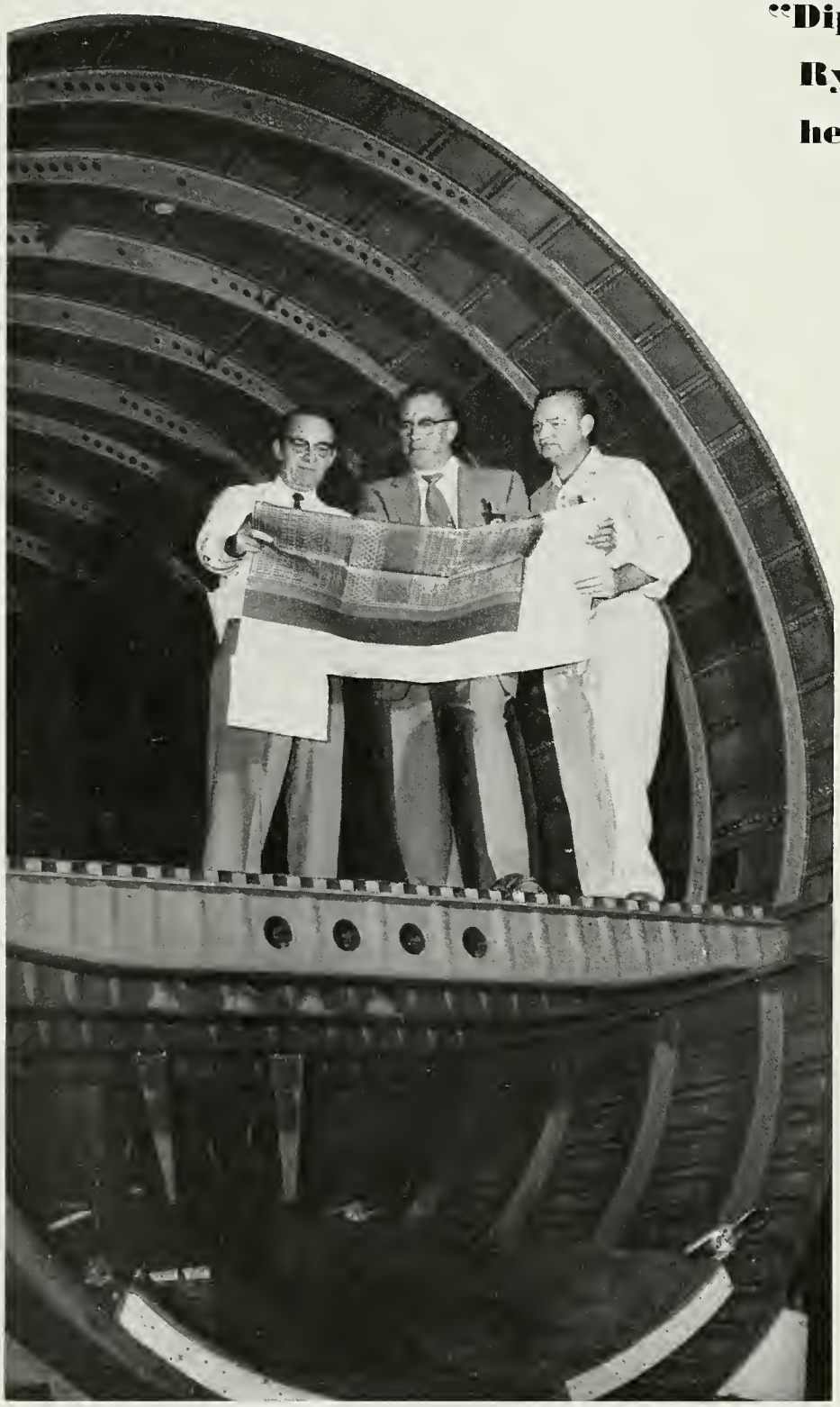
Ryan REPORTER



VOL. 15, NO. 6

INDUSTRIAL

"Diplomats" representing Ryan's major customers help promote teamwork essential to efficient output



BOEING Examining blueprint in one of more than 675 giant aft fuselage sections built by Ryan for KC-97 transport-tanker are Robert Welsh, Boeing Airplane Co. representative, at left, with Paul Matherly, of Ryan engineering department, in center, and Ray House, of Ryan inspection.

INDUSTRIAL "ambassadors," many miles from their home offices, operate in Ryan Aeronautical Company's San Diego plant.

They have been assigned to Ryan because of the importance and volume of work being performed on jet and piston engines and airframe components.

They move unobtrusively through the shops, the inspection areas and the shipping and receiving warehouses as they serve the interests of their employers, whose orders at Ryan run into millions of dollars.

These "diplomats" are the representatives of some of Ryan's major customers, and are considered members of the Ryan "family' as they integrate their activities with the departments responsible for their companies' products.

Teamwork between Ryan and its customers is an essential ingredient in the economical and efficient production of today's complex aeronautical products.

Many prime contractors find it expedient to have on-the-spot representation in plants of vendors to perform liaison functions. As problems arise, they often can be swiftly settled through such intermediaries.

These representatives have varied responsibilities. Some are concerned entirely with engineering phases, others with material flow, and others with quality control. The mission of all is to help maintain uninterrupted delivery schedules.

One of the Ryan customer's representatives put it this way:

"In the past, a question over a completed item might involve shipment of the article back and forth across country, numerous long-distance calls and a lot of paper work.

"Today, many of these problems can be settled on the spot, so that the finished product is fully acceptable before it leaves the vendor's plant.

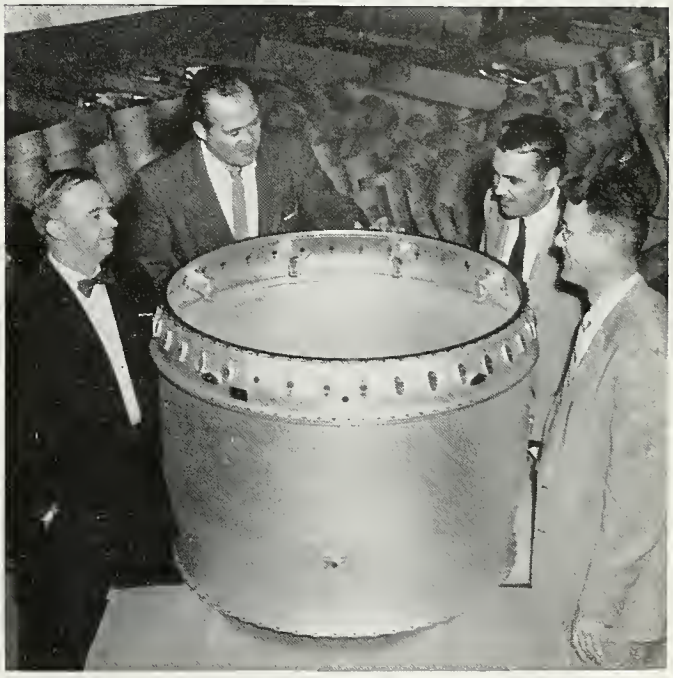
(Continued on Page 2)

AMBASSADORS

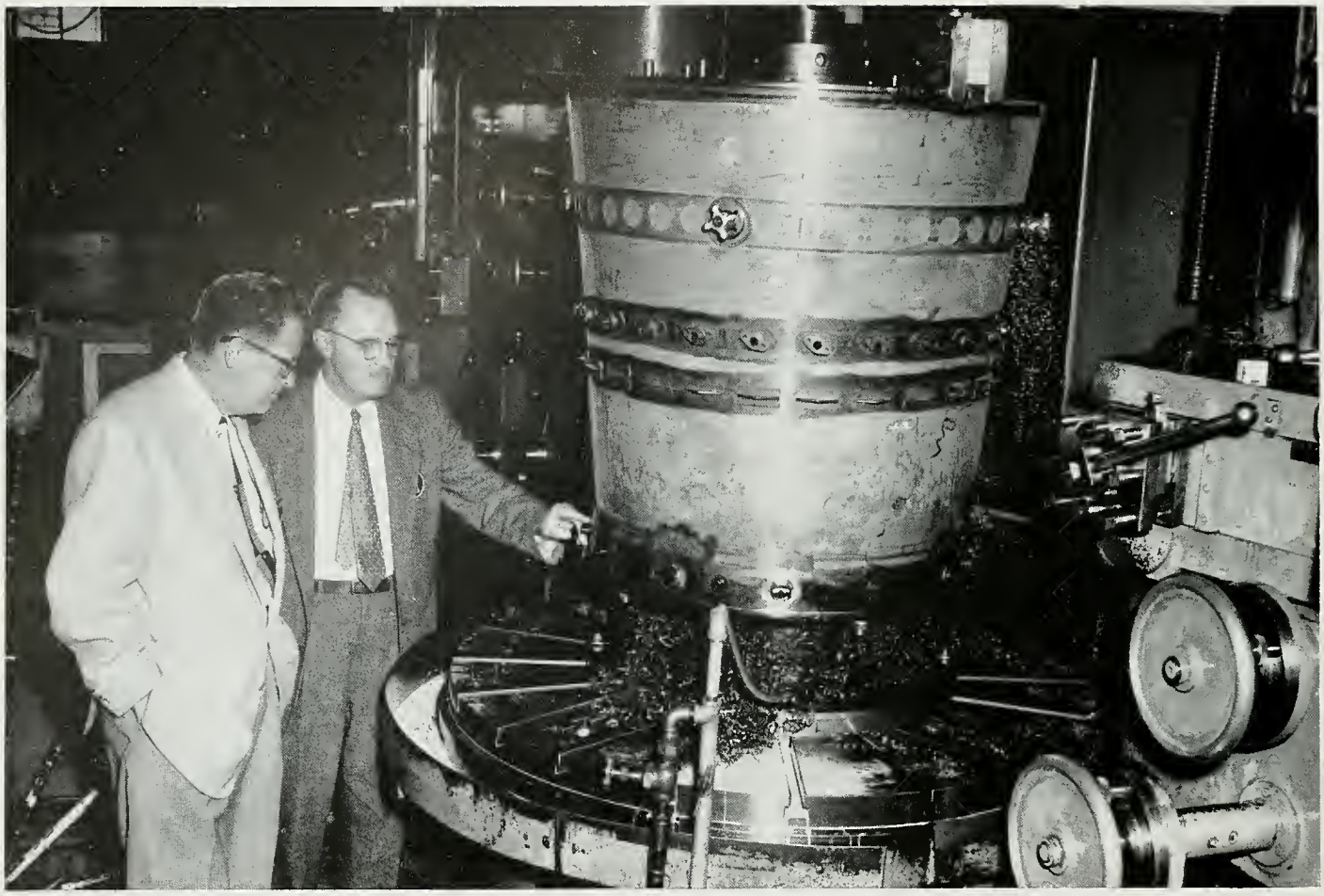
A Westinghouse afterburner component produced by Ryan is checked by A. H. Stone, of Westinghouse, left, and Byron Geer, Ryan coordinator. Stone's headquarters are in Los Angeles, but he spends much time in Ryan factory.

G. R. Robertson, at left, General Electric representative stationed at Ryan, inspects J-47 part with E. A. Claypool, G.E. zone supervisor, whose office is in downtown San Diego. Ryan is one of G.E.'s major suppliers.

Irving E. Lundin, control metallurgist, at left in phato, has established "source inspection" in the Ryan plant to assure acceptance before shipment to Pratt & Whitney Aircraft. Shawn with him viewing J-57 jet engine parts is H. V. Bilben, Ryan receiving inspection supervisor. Ryan also produces manifolds for P. & W. piston engines.



Four men represent Curtiss-Wright at Ryan, where J-65 jet components, such as shown above, the J-65 afterburner and turbo compound engine nozzles are made. Left to right in photo: Wayne Pangborn, Paul D. Lella, Pat Raftery and John Hess. Latter recently was transferred to another factory, and was succeeded at Ryan by Henry Jin.



Ford Motor Company's Chicago plant, builders of the J-57 engine under license from Pratt & Whitney Aircraft, has assigned Francis P. Burke, left, as its representative at Ryan. Occasionally, specialists from headquarters, such as A. F. De Viney, right, are sent to Ryan for brief periods to enhance coordination between the two plants.

"With an inspector and engineer stationed in the vendor's plant and carrying a certain amount of authority, they can make disposition of any questioned part. Sometimes, there are minor discrepancies which do not affect the utility of the part. Unless the prime contractor's representative is in the vendor's plant to give it his stamp of approval, considerable time can be wasted unnecessarily in reaching the proper decision."

The "dean" of industrial "ambassadors" with his office in the Ryan plant is Robert J. Welsh, quality control representative for Boeing Airplane Co., Seattle.

Ryan, for several years, has been one of the major suppliers of large component parts for such planes as the Boeing KC-97 transport-tanker, the B-47 bomber, and Boeing's newest bomber, the B-52. Tens of millions of dollars worth of products have been produced by Ryan under Welsh's practiced eye on an assignment that read "temporary" when he was sent here.

Because of the large quantity of work subcontracted by Boeing throughout Southern California, other representatives are in this area. San Diego actually is headquarters for Southern California, as far as Boeing is concerned. John Brockway, materiel department representative for Southern California, resides in suburban La Mesa. He is one of the veterans of the aircraft industry. Next February, he will celebrate his 19th year with Boeing, except for service in World War II.

Discussing Ryan's work on "Corporal" rocket engines are J. J. Potterson, Firestone representative, seated, and Wally Adams, an inspection supervisor at Ryan.

Another major Ryan customer, General Electric, for whom thousands of parts have been produced for the noted J-47 jet engine, has five representatives, one of whom, G. R. Robertson, is stationed full-time at Ryan. The others are E. A. Claypool, zone supervisor for the entire West Coast, whose office is in downtown San Diego; R. A. Dewing, production supervisor, and Stan Williams, engineer. All visit the Ryan plant several days each week. Harold Langston is another of General Electric's zone representatives in San Diego.

The background of customer representatives is often quite extensive. Robertson, for instance, has been in aviation almost 19 years. He enlisted in the Army in 1933, transferred to the Air Force

(Continued on Page 29)

Accent On Tomorrow

Air Research and Development Command peers into the future for problems that can be solved today

THE realization that survival of the United States as a nation may well depend upon its ability to maintain world leadership in the air has led to a tremendous teamed effort on the part of the government, science and industry in an aviation research and development program of unprecedented scope and intensity.

Reassuring to the nation are the momentous advances being made in aviation today. Toward this end, a dominant role has been played by the Air Research and Development Command—nerve center of the U. S. Air Force technical development effort.

It was during the second World War that science and technology emerged in their present dominant role of shaping the nature and outcome of warfare.

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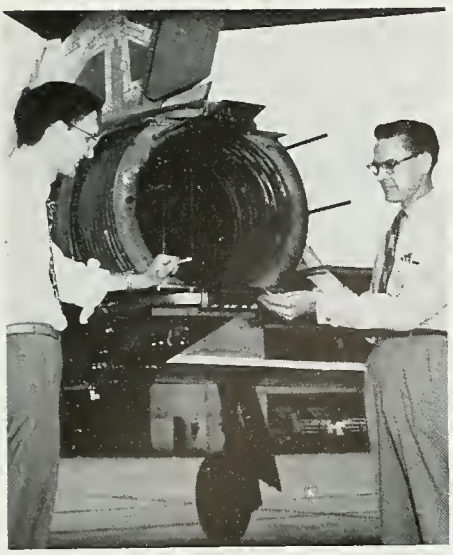
All Official U. S. Air Force Photos

Dressed for their work, these high flying pilots are wearing T-1 partial pressure suits developed by ARDC for their protection.



One of ARDC's "in house" developments is this experimental thrust-reversal device designed to reduce forward speed of jets.

Lt. Gen. Thomas S. Power, USAF

As commander of the Air Research and Development Command, General Power directs operations at ten research and development centers scattered throughout the country. He was formerly SAC's vice comdr.

Strapped to a rocket-propelled test sled and wired for reactions, Lt. Col. Stapp prepares for 421 mph ride on test track.

The growing importance of military research and development was revealed clearly in the light of such technical developments as radar, the atom bomb, the proximity fuse, the V-2 rocket and jet propulsion.

When final victory in Europe brought the all-important race for technical supremacy to a halt, the United States found that it had been losing ground to the Germans. This was especially true in the fields of jet propulsion, rockets and guided missiles, although the U. S. did hold the edge in electronics and atomic weapons.

But while lagging in technical developments to some extent, the U. S. was far out front as far as industrial output was concerned. For this reason, it is generally recognized that the war in Europe was won with the overwhelming quantity of weapons produced in this country. Unfortunately, this great quantity was achieved only at the expense of quality, and American equipment was often inferior to that of the enemy. The closing days of the war saw the Germans bringing into operational use technically superior weapons that the U. S. Army Air Force might not have been able to match had the war continued.

In postwar years, the philosophy of quantity over quality was recognized as unfeasible and discarded. In its place, a vital significance was attached to research and development as the only means by which this country could attain the technical superiority needed to offset the mass of manpower and materiel available to our potential enemy. As Defense Secretary Charles E. Wilson has said, "Technology, through providing us with superior weapons and the knowledge of how to use them, offsets the possible greater numerical superiority of a potential enemy."

Within the U. S. Air Force, this new philosophy was given full expression with the establishment on April 2, 1951, of a separate major air command—ARDC—to serve as the nerve center for all research and development activities carried on by or directly for the Air Force as a part of its increased technical development effort.

From its headquarters in downtown Baltimore, Md., ARDC directs operations at ten major research and development centers scattered throughout the country. It supervises contracts for research and development conducted for the Air Force at universities, private and non-profit research organizations, and industrial research and development corporations, monitors their work, and tests and evaluates their results.

In general terms, the mission of ARDC is to assure the technological superiority of the Air Force over any potential enemy of the United States. The Air Force has further defined the ARDC mission as follows: (1) Attain and maintain qualitative superiority of materiel and conduct or supervise scientific and technical studies required for the establishment of the Air Force mission; (2) Seek basic new knowledge from which improved aeronautical equipment, materiel, weapons and techniques can be developed; (3) Undertake the development and recommend adoption of appropriate new and improved devices and systems for the conduct and support of air warfare, including aircraft, missiles, weapons, techniques and procedures applicable to Air Force purposes.

The job calls for continually increasing the immediate striking and defensive power of the Air Force through continuous improvement of its aircraft, guided missiles, equipment and techniques. Superior weapons for the future must be provided through scientific and technical investigations and the acquisition and application of fundamental knowledge.

To accomplish the task, ARDC works hand-in-hand as a productive team with those in the military establishment, in industry and in science. The Command functions primarily as a liaison between the user commands who need new and improved equipment and the scientists and engineers of the academic and industrial world who can develop it or contribute knowledge to the development problems.

Indicative of this close collaboration is the fact that ARDC in 1953 spent 87% of its total funds for work by non-Air Force agencies on research and development contracts. Included were approximately 160 universities, colleges, and other non-profit organizations and 1520 industrial companies. The limited amount of research and development ARDC does in its own facilities is that necessary in support of its test facilities or work to advance the state of the art in fields where industrial or academic sources are not sufficiently interested to take the job.

To facilitate dealings with the aircraft industry, ARDC headquarters is set up in much the same manner as an industrial organization rather than the traditional military-type organization. A recent reorganization provides for a Deputy Commander for Technical Operations and a Deputy Commander for Support Operations. The former is responsible for all aspects of ARDC's research, development, test, and aircraft program while the latter is responsible for providing and managing resources and services.

A new concept initiated by ARDC is that of developing new air weapons as a complete system that will include all of

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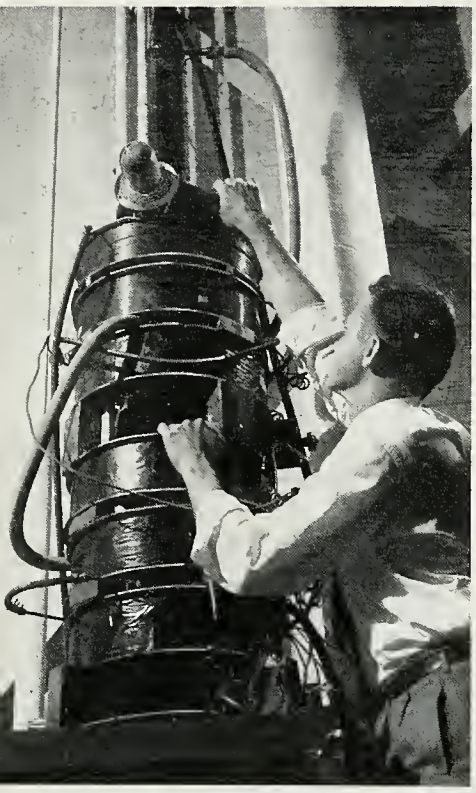
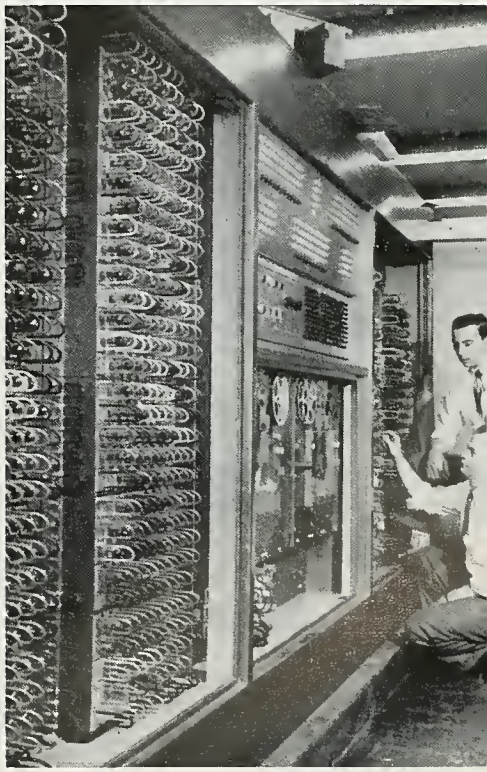


This huge electronic tube is a super-powered klystron which produces four million watts of radar power. Sperry Gyroscope Co. developed it for ARDC.

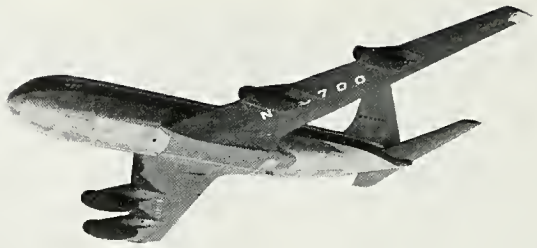
Catapulting downward from a hatch in the bottom of a B-47 Stratojet bomber traveling at a speed of more than 500 miles per hour, an ARDC Aero-Medical Laboratory volunteer tests a downward ejection escape system. The ejection seat is mounted on rails and is driven downward by explosive cartridge. Parachute opens automatically.

Part of ARDC's stable of research aircraft under test at Air Force Flight Test Center, Edwards, Calif., includes (reading clockwise from lower left): the Bell X-1A, Douglas D-558-I, Convair XF-92A, Bell X-5, Douglas D-558-II, Northrop X-4. The Douglas X-3 in the center of the group. The XF-92A and two Bell X-4s have been "turned out to pasture."

Produced for ARDC by General Electric Company, new digital computer called "OARAC" solves the problems involving aircraft design with lightning speed.



Ryan-Boeing partnership extends to America's first jet transport



Jet Tanker Sub-Contract

RYAN AERONAUTICAL COMPANY will participate in the construction of America's first jet tanker-transport, the U. S. Air Force's new Boeing KC-135, it was revealed recently with award to Ryan of a contract for major fuselage sections. It is one of the first sub-contracts to be awarded by the Boeing Airplane Company of Seattle on its new tanker-transport which is an advanced development of the prototype 707 jet transport.

The initial release on the new Stratotanker assembly order at Ryan is for approximately $3 million. Tooling for production will get under way immediately on the project, which may develop into a six-year program, T. Claude Ryan, company president, said. Ryan's present Boeing sub-contract program on the KC-97 Stratofreighter has totaled approximately $50 million with a backlog of more than $10 million in undelivered orders currently in work.

For the KC-135, Ryan will build the aft fuselage section, an airframe component with which this company has gained much experience during the past five years when it has manufactured this major assembly for the predecessor of KC-135 tanker-transport, the KC-97 piston engine Air Force transport.

A large "torque box" structure inside the fuselage, an important unit of the KC-135's flight controls system, also will be built by Ryan. The stabilizers are attached to this box.

The Boeing KC-135 is the advanced, all-jet successor to the Boeing KC-97, and was ordered into production by the Air Force on Sept. 1, 1954. Its design is based on the Boeing 707, America's first jet transport plane, which has been test flown successfully at speeds in excess of 550 miles an hour and at altitudes above 42,000 feet. Boeing developed this plane as a private enterprise "gamble" that cost $15 million. It made its first flight on

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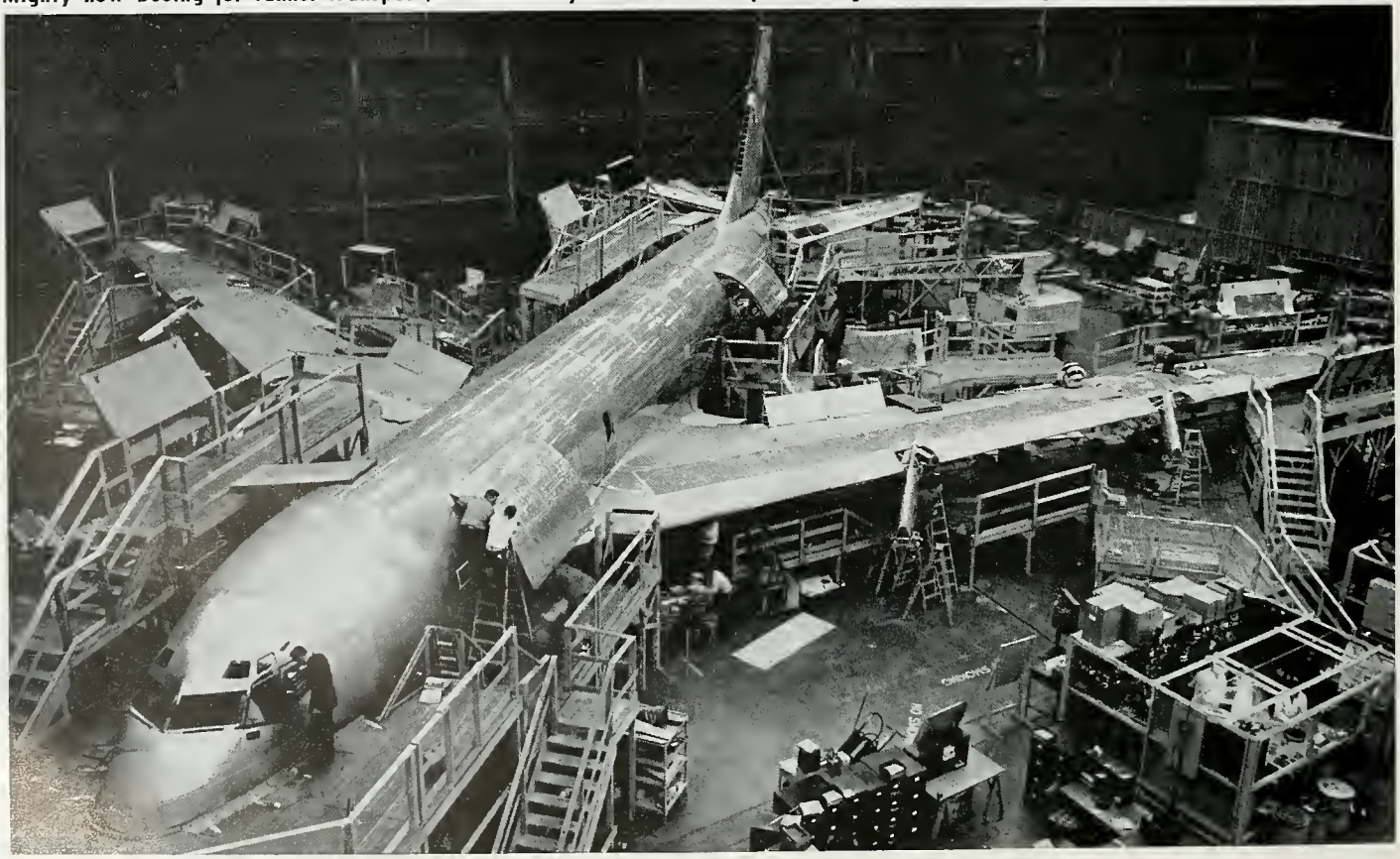
Mighty new Boeing jet tanker-transport, for which Ryan will build major fuselage sections and important flight control system unit.



TURBO-PROPS PAY OFF

A victim of sporadic development, the turboprop engine now shows signs of definite promise

LONG a neglected offspring of the jet age, the turboprop engine is at last receiving its due portion of the attention that has been heaped upon its cousin the turbojet by this country's aviation industry.

Military and commercial interest in turboprop-powered aircraft is today at an all-time high. Virtually all of the leading transport manufacturers have specific pro-

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Largest turboprop engine known to be flying today is the Pratt and Whitney Aircraft T-34. Take-off power at sea level is 5,500 eshp.

The world's fastest propeller-driven transport, the Lockheed R7V-2 Super Constellation is powered by four Pratt & Whitney T-34s.

Powered by an Allison YT-40-14 turboprop engine, the Convair XFY-1 vertical take-off fighter is being flown successfully.

posals for turboprop transports, some of which are advanced versions of present models while others are completely new models.

Ardent turboprop enthusiasts attribute this new trend, at least in part, to the unprecedented move made by Capital Airlines in ordering British-made Vickers Viscounts—powered by four turboprops—for domestic use. This threat of serious British competition in the American commercial aircraft market has, they feel, given the turboprop engine a big boost toward commercial service in this country.

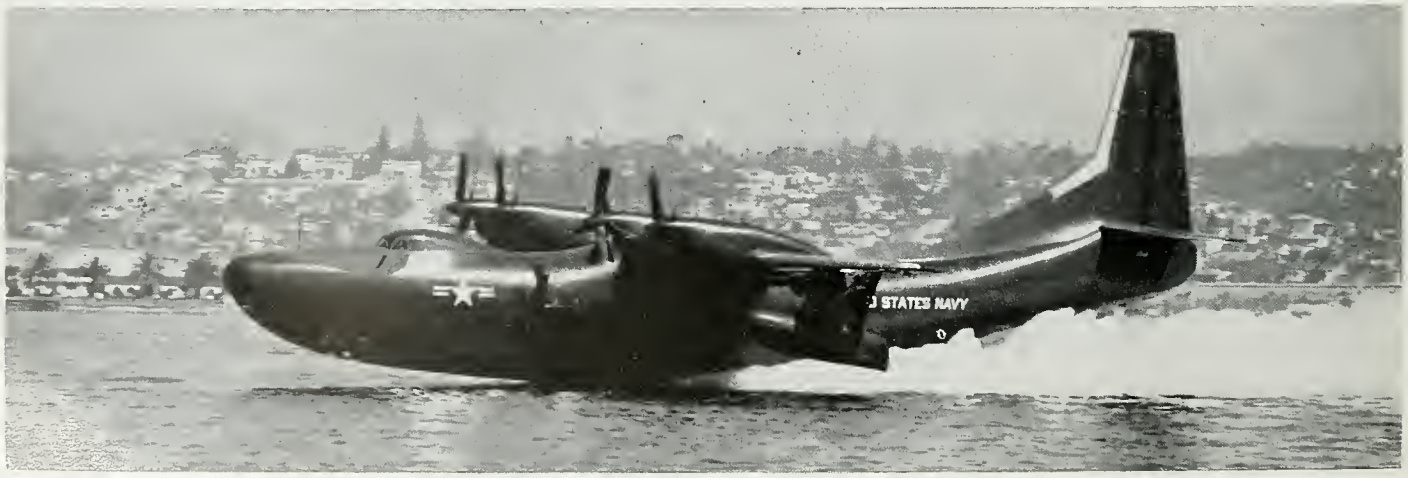
Whatever the reason—and there are many from which to choose—there are definite signs that turboprop powerplants are figuring prominently in both military and commercial plans for the future.

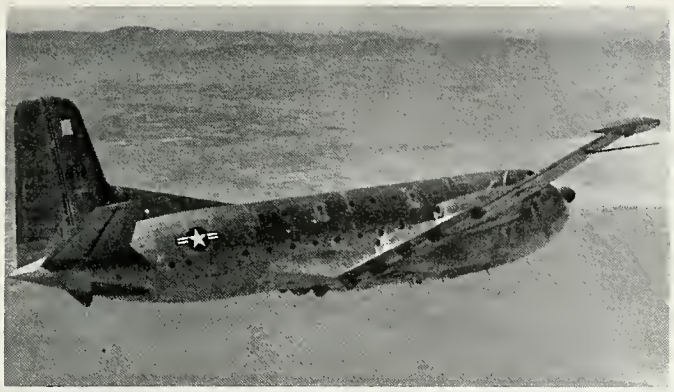
Some of these signs: A. E. Raymond, Douglas Aircraft Company's vice president-engineering, has stated that his company will probably come out with a turboprop version of the DC-7 when suitable engines become available; C. L. Johnson, chief engineer at Lockheed Aircraft Corp, has said that turboprop Super Constellations could be delivered to the airlines in from two to two-and-a-half years' time if orders were placed within six months; officials of the Allison Division of General Motors Corp. say that Allison can deliver commercial versions of the T-56 turboprop engine by spring of 1957—providing the Air Force approves.

On the military side of the picture, Lt. Gen. Joseph Smith, commander of the Military Air Transport Service, gave considerable emphasis in a recent speech to the MATS' requirement for a turboprop transport to carry cargo. Adding weight to his remarks was the recent first flight of Lockheed's YC-130 military transport, powered by four Allison T-56 turboprop engines. Also in production for the military is the Douglas C-133A with its four Pratt & Whitney Aircraft T-34 turboprop powerplants.

While the United States has made remarkable progress in the gas turbine field, it has lagged behind in harnessing this new form of propulsion to the propeller. In contrast to the extensive experience the British have accumulated, relatively

Fastest flying boat in history of water-based aviation is Convair's turboprop-equipped R3Y-1 transport developed for U. S. Navy.





Developed as a flying test bed for the T-34 engines that will power the Douglas C-133A, the huge YC-124B is now under test.

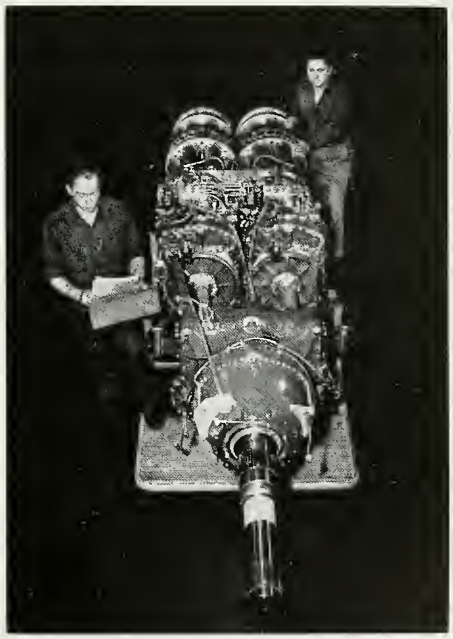
First turboprop airplane to see service on any U. S. airline will be British-built Viscounts ordered by Capital Airlines.

little time has been logged with turboprop aircraft on this side of the Atlantic.

Principal reason for lagging in this country can be traced back to what has been dubbed by many the "postwar economy era." At that time the turbojet, because it offered higher speeds, appeared to be the most promising in the highest-priority military applications. Something had to go, so the turboprop was sacrificed in order that the lion's share of development could be devoted to the turbojet.

Since then, a marked change in attitude toward the turboprop has taken place. Within the military services and the aircraft industry there is a growing realization that the turboprop powerplant offers an excellent compromise between the speed of the turbojet and the economy of the piston engine.

Each type of engine—turbojet and turboprop—has individual advantages. In the case of the turbojet, it is speed. The turbojet transport is likely to establish itself in commercial service as the "plush" non-stop, cross-country and transoceanic carrier. It will probably be utilized by the military for the express purpose of transporting personnel and wounded when speed is a paramount factor.



Allison employees prepare gleaming new T-40 turboprop engine, currently rated at 5850 esph., for a run on test stand.

The turboprop aircraft, on the other hand, is ideally suited for both short and long range flights where speed is not critical. The turboprop offers two important advantages: lower fuel consumption and the quick acceleration and deceleration characteristics of propeller power. Boosters for the turboprop claim that the very small speed advantage of turbojet planes is far outweighed by the turboprop's savings in fuel costs.

Basically, the turboprop is very similar to the jet engine that powers today's high speed jet fighter and bomber aircraft. They both employ a compressor and turbine—attached to a common rotating shaft. As air enters the turboprop compressor, which acts like a large fan, it is compressed and forced into combustion chambers. There it is mixed with fuel and ignited. As the mixture burns, hot expanding gases are formed. Rushing out of the chambers, these gases spin the turbine wheel.

The power generated by the turbine is

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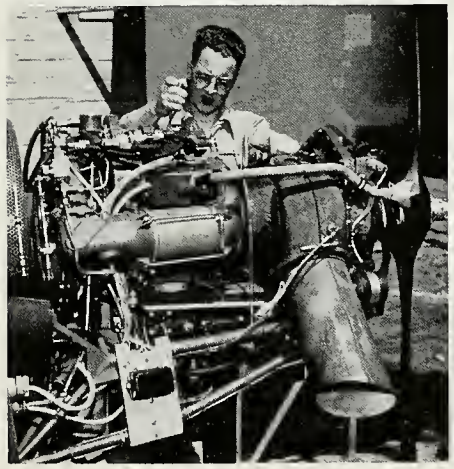
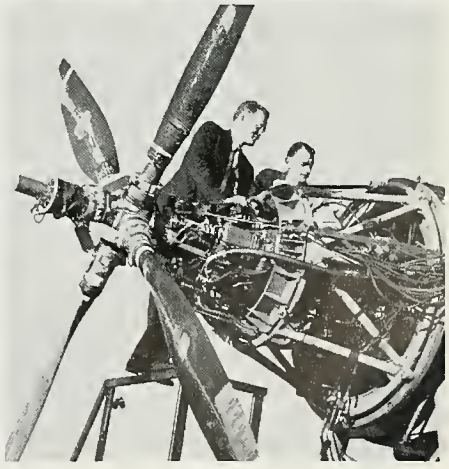
One of the smallest turboprop engines in this country is the Boeing XT-50-1 which powers Cessna Aircraft Company's XL-19B.



Ryan pioneered the use of turboprops in the Navy with development of the XF2R-1 powered by the General Electric TG-100.

Prototype of General Electric's TG-100 turboprop engines—first of its kind in the world to fly—was unveiled in 1945.



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5,681 YEARS OF EXPERIENCE WITH RYAN IN THE AIRCRAFT INDUSTRY

Printed on this page are the names of 422 Ryan employees who are entitled to wear the diamond studded gold service pins representing ten through twenty-five years of service at the Ryan Aeronautical Company.

As a leader in the production of a wide variety of products, Ryan feels it is of great importance that of our 4,000 employees, 10½% of them have been here over ten years and 31% over 5 years. This fact plays no small part in assuring the continuing high quality of Ryan products.

Ryan has an annual business volume of $40-$50,000,000 and an annual payroll of more than $20,000,000. Our 750,000 square feet of production floor space represents an investment of more than $4,500,000 for buildings, tools and equipment.

But the most important part of Ryan is the experience, abilities and morale of our organization —its people— its workmen, engineers, supervisors and managers. They represent a basic value greater than all the inventories, buildings, machinery, cash and other tangibles which the company possesses.

PILOTLESS AIRCRAFT

"The Little Man Who Wasn't There" flies high, far and fast in a variety of vehicles

by Curtis L. Bates, Ass't. Director of Engineering, Ryan Aeronautical Company

PILOTLESS aircraft are rapidly acquiring the versatility to span the spectrum of military missions. This trend is indicated by the increasing importance of missile and drone research and development in the aircraft industry. To illustrate the problems encountered in missile drone projects, such as the Ryan Firebee, it might be helpful to point out the differences between these air travelers and piloted planes.

For simplification, we will confine our remarks to pilotless aircraft powered with turbojet engines, eliminating such categories as ballistic missiles and the short range air-to-air missiles. The general problem areas can be broken down into airframe, propulsion, guidance systems, launching equipment and the inevitable miscellaneous category which would cover such things as warheads and equipment required for special missions.

The pilotless aircraft field covers a range of sizes and missions, starting with target drones of perhaps 1000 to 1500 pounds gross weight, requiring engine thrust of less than 1000 pounds, and extends all the way up to the recently announced intercontinental bomber comparable in weight to a piloted bomber and requiring engines in our highest thrust categories. Let us examine problems in each of the areas described above.

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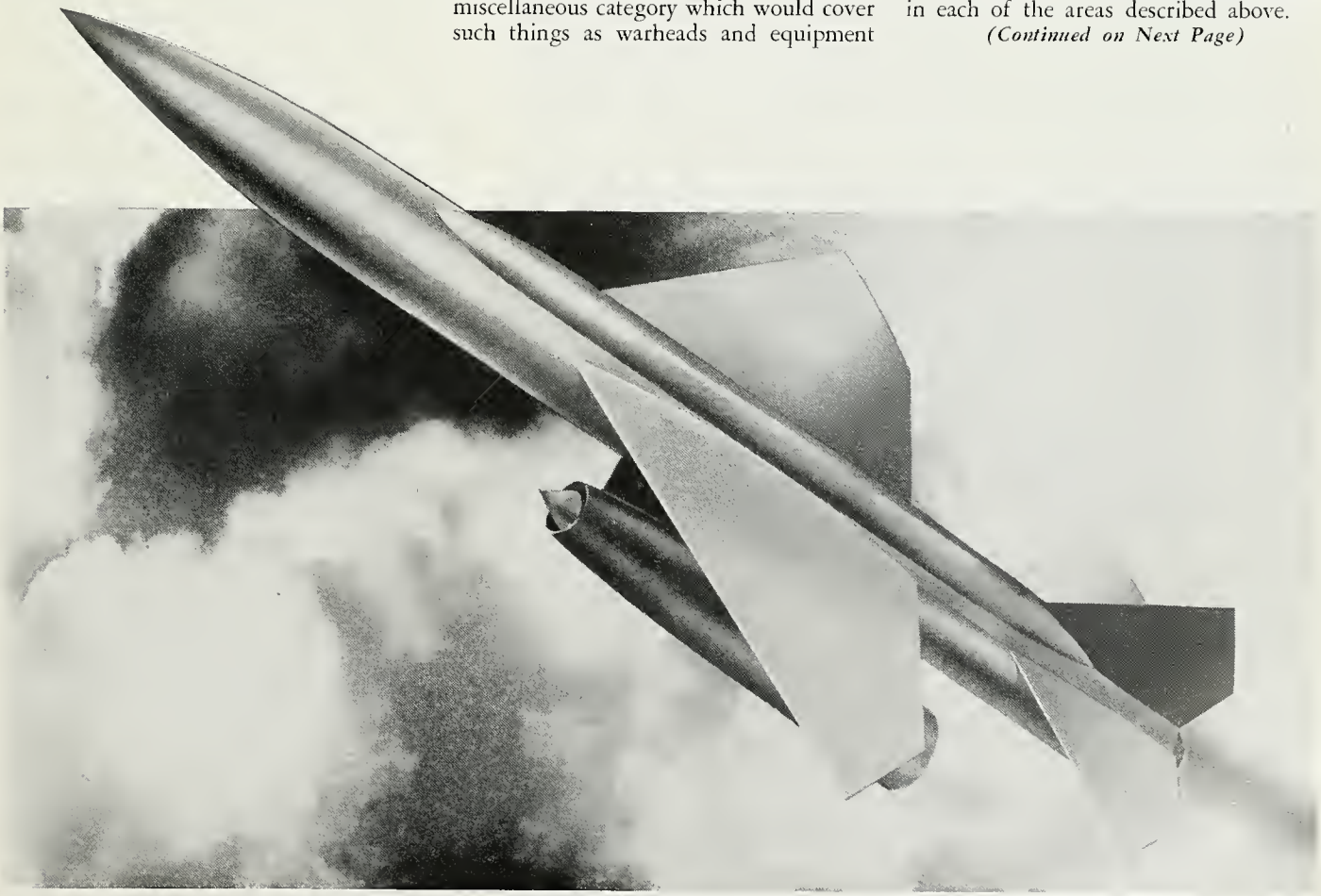
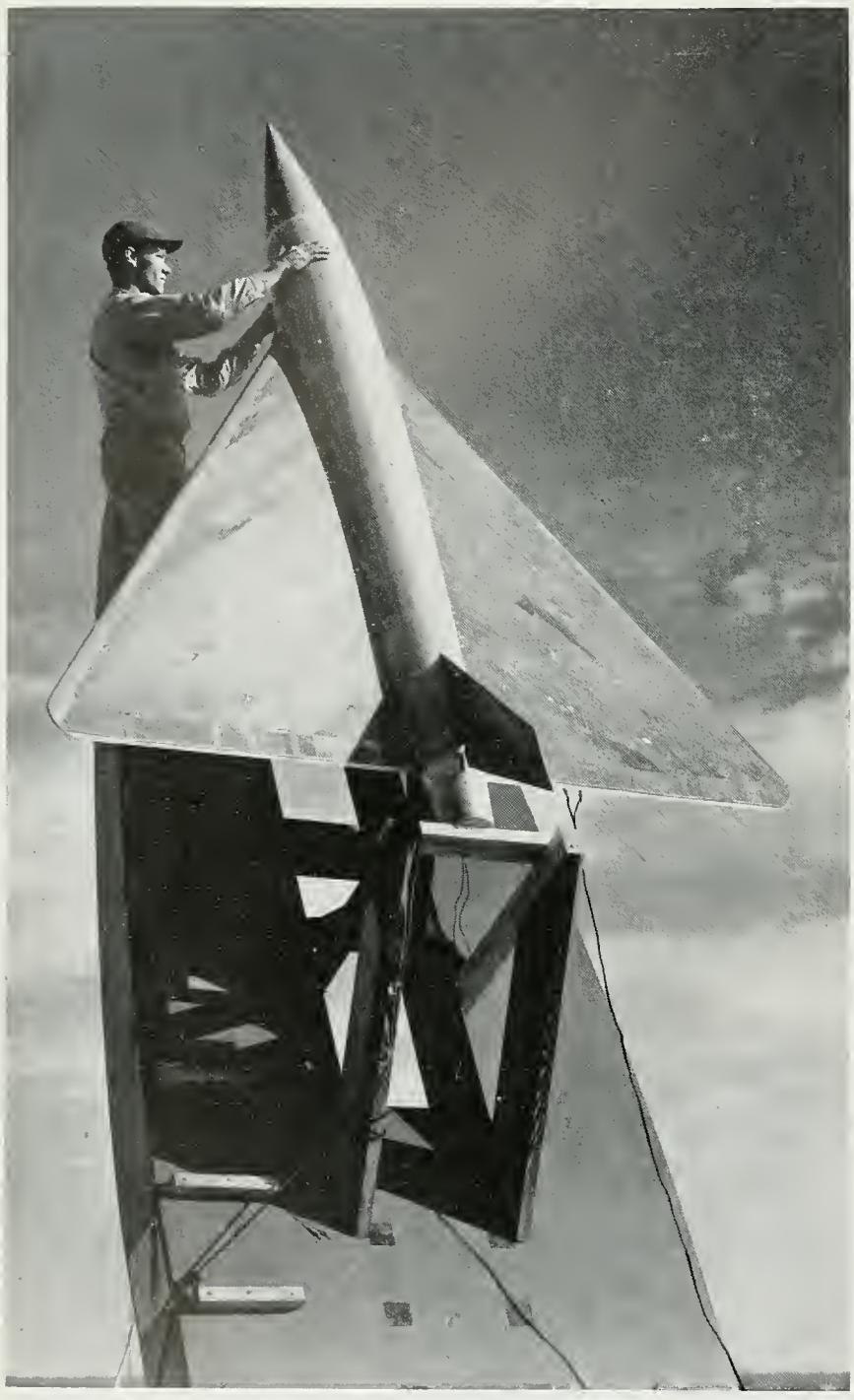


Cloaked in military secrecy, Boeing's F-99 Bomarc guided missile is shown in this sketch as a sleek, delta-winged traveler.



Powered by an internal rocket which is capable of pushing it up to supersonic speeds, this research model of a delta wing missile was developed by the NACA to measure the amount of drag created by sharply swept back, triangular wings.

AIRFRAME

The airframe problems are similar to those in piloted aircraft. There are, however, certain outstanding differences. Missiles which are designed for a single flight and are to be expended at the end of the mission do not have the requirements for repairability which we design into our piloted aircraft. The balance of production and operating costs against allowable weight and the required degree of aerodynamic cleanness must be viewed from the standpoint of the specific mission and operating conditions. This leads to a different set of compromises based on the different conditions, but the same factors enter into the analysis.

In general, the missile category should require less in the way of safety precautions than we require in a piloted airplane. However, there is a requirement for greater reliability in all the functional parts since there is no human pilot to compensate for a failing component. The general problem of reliability is one of the major problems facing all missile manufacturers. The proper fulfillment of a missile mission depends upon several hundred detail components performing with 100% reliability under the conditions imposed.

The so-called thermal barrier is not a definite thing such as the sonic barrier. Rather it is a gradual increase in temperature with speed. A great deal of the effort is being expended on the development of new materials for airframe use in the high temperature missile. The problem extends much farther than the structure. Electronics equipment now malfunctions at temperatures as low as 200° F. and at these temperatures the life of many items of equipment is very short. Normal fuels are unsatisfactory for use in high temperatures and it is difficult to provide adequate fuel cooling. Some warhead materials become unstable and dangerous at comparatively low temperatures. We are gradually invading this technical barrier as we settle more and more of the problems involved.

PROPULSION

The turbojet engine is a relatively complex and costly piece of machinery but for many applications it appears to be the logical power plant for missile use. A number of attempts have been made to develop an expendable turbojet engine. It has been found that an engine which is thoroughly reliable for a period of one to twenty hours—a normal life requirement for a missile engine—can be made reliable for a long period with little additional effort. Certain notable steps are being taken in the use of non-strategic materials and high thrust ratings for short period operations. The prospect of having a really cheap and expendable turbojet engine is not bright.

One area needing further and more rapid development in the propulsion field is the development of fuels with higher specific heats. Even higher density fuel with the same specific heat would be a considerable advantage, since total missile volume is highly dependent upon the fuel volume required.

GUIDANCE SYSTEMS

Problems in the field of missile guidance are probably the most serious in the whole missile field. For short range operation it is possible to resort to radio or radar control. The techniques for this

type of control have been in use for some time and are now well worked out. This type of guidance is obviously limited by the range of the radio or radar system. It is also subject to interference and false commands from many sources. Some sources also feel that this method of control is particularly vulnerable to enemy action. The system is also limited since the accuracy decreases with the distance from the controlling station.

In long range missile applications—more than a few hundred miles—it is necessary to resort to control which is not related to ground equipment. This might be done by straight dead reckoning but would require the accurate prediction of all disturbing influences, such as wind variations, and would require more accurate launching and control systems than appear practical.

The dead reckoning system can be improved considerably by installing space references in the form of inertia units such as very accurate gyros. Even with these precise instruments the system is still faulty since the inaccuracies increase with distance travelled. Divergence would be eliminated by use of celestial references and the system can be made convergent by homing on the target itself. While many types of homing devices have been investigated, the problem of homing on an object several thousand miles away is obviously not a simple one.

The problem of reliability is more acute in the guidance equipment than anywhere else in the missile. Electronics equipment in particular has been difficult to produce with the required degree of reliability. Environmental conditions are such as to affect the operating characteristics of many pieces of guidance equipment, particularly the electronic ones. We require the same piece of equipment, operating at temperatures from perhaps 160°F. on the ground on a sunny day to minus 80°F. at high altitude; and from sea level pressures to the very low pressures at an altitude of 60,000 feet; to withstand exposure to the elements, perhaps many months before an emergency requires launching of the missile and to be ready at any moment for such launching.

LAUNCHING

In the field of launching equipment the problem is perhaps as much economic as technical. Many missiles are launched by means of rocket power, but it is not always realized that the cost of the rocket device, with a useful life of only a few seconds, may amount to as much as 10% of the total missile cost. This, of course, is a cost for each launching and is in addition to the rather elaborate installations

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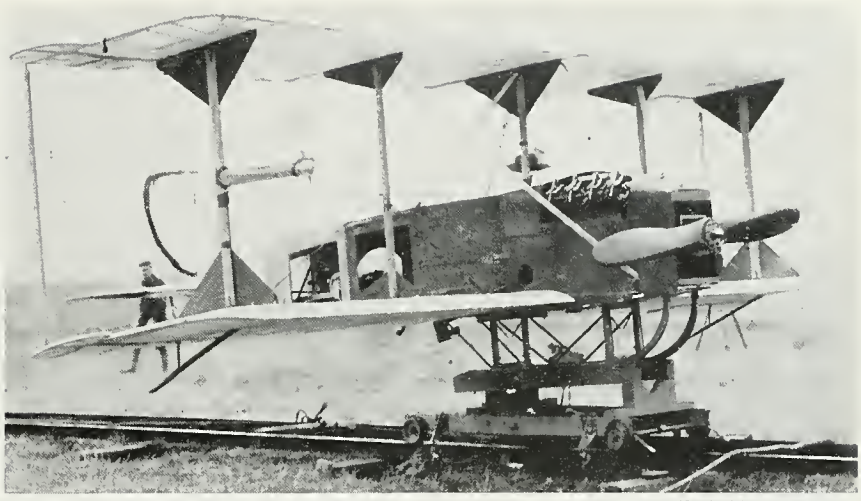


U. S. Navy Photo

ABOVE:

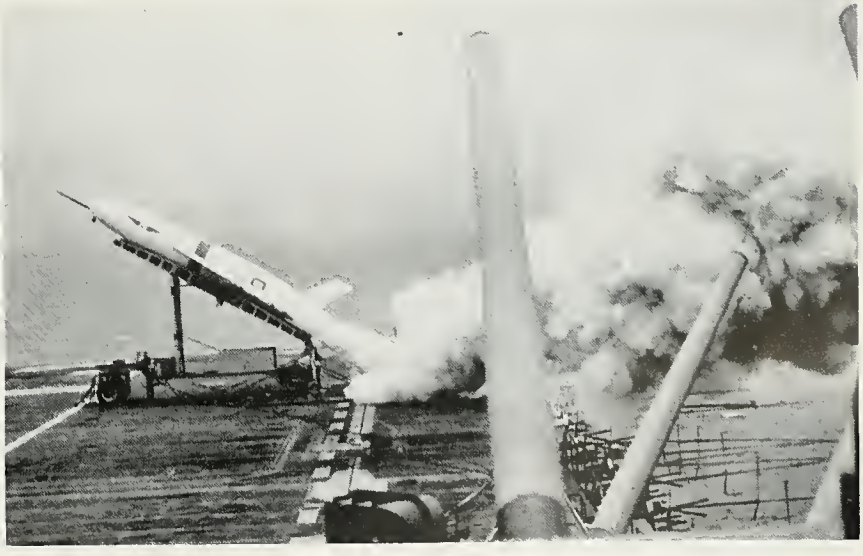
World's first missile with an automatic pilot was the 1917-18 "flying bomb" developed by Curtiss-Sperry. It had a range of 50 miles and a top speed of 90 mph.

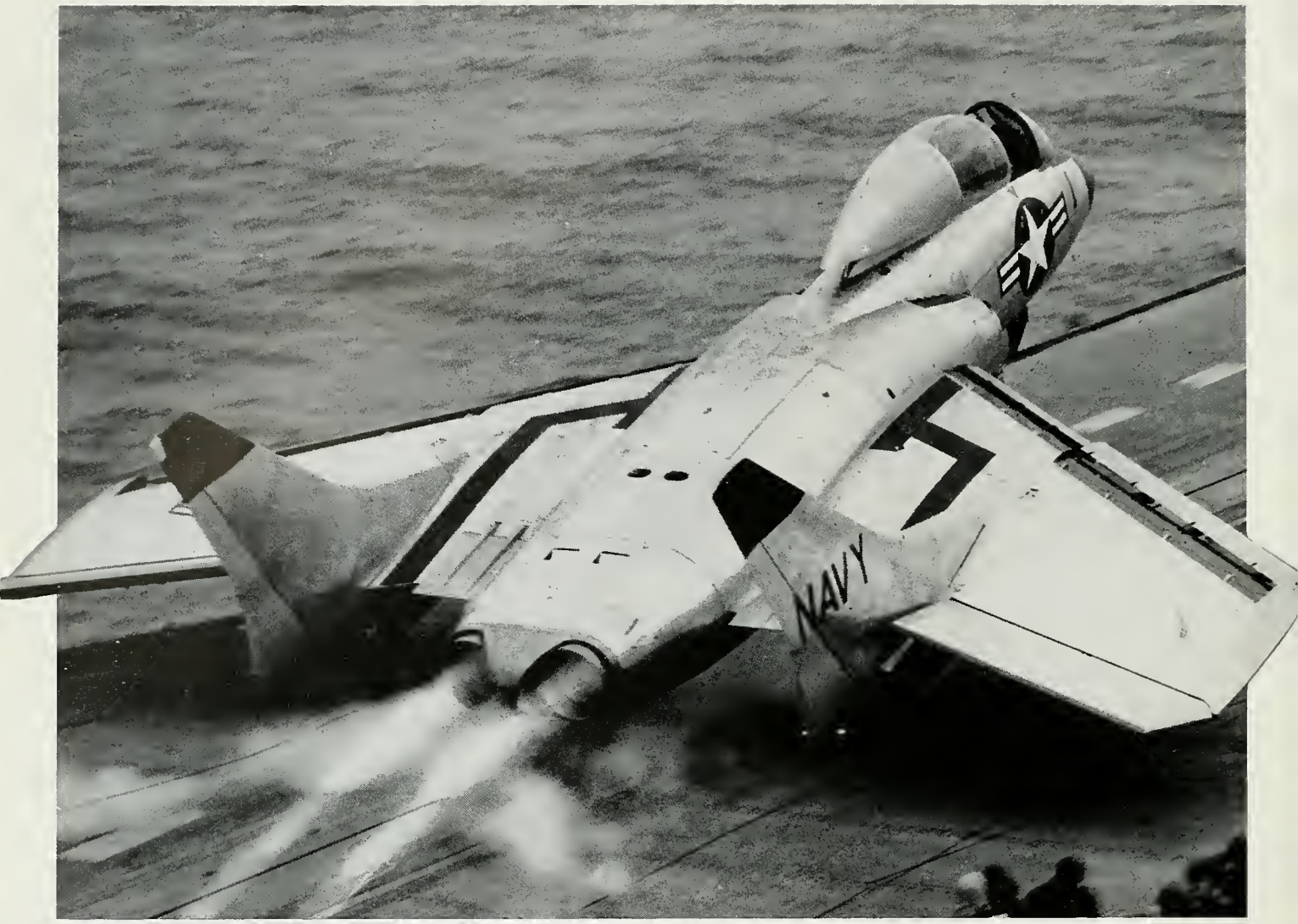
RIGHT:

Roaring into the sky from a small portable launcher, the Martin Matador is a huge missile powered by a full scale turbojet engine.

BELOW:

Deck launching from a warship or submarine is routine for Chance Vought's Regulus, a radio-controlled missile with landing gear. *(U. S. Navy Photo)*





Blasting off from the deck of Navy carrier, the pilot of this F7U-3 turns on the full power of his twin engines and afterburners.

RYAN AFTERBURNERS BLAST U.S. JETS AHEAD

Another Example of How

RYAN BUILDS BETTER

RYAN

HOT SHOT TWINS GIVE CUTLASS DOUBLE EDGE

Dual afterburners built by Ryan provide additional speed for versatile new Navy plane

Double burst of flame from the F7U-3 Cutlass afterburners was used as a model for the latest in Ryan's dramatic new series of magazine advertisements.

Official U. S. Navy photo by VC-61.

Fastest of the Navy's fighters now in wide service, these four Cutlasses are shown flying over the coastline of San Diego, Calif.

AS VERSATILE as an actor in summer stock, Chance Vought's twin-jet F7U-3 Cutlass handles the multiple roles of fighter, interceptor, photo reconnaissance and ground attack plane, to give the U. S. Navy a star performer in its carrier-based air fleet.

Fastest of the shipboard fighters currently in use by the Navy in any significant numbers, the Cutlass is reported to have a top speed of more than 700 mph. Other versions of the plane clock in at slightly lower speeds.

Powerplants of the unique aircraft in all its roles are two Westinghouse J-46 turbojets fitted with Ryan-built afterburners. Mounted side-by-side in a broadened fuselage, the twin jets have a combined thrust of 12,000 pounds, with considerably higher power provided for short periods by dual afterburners.

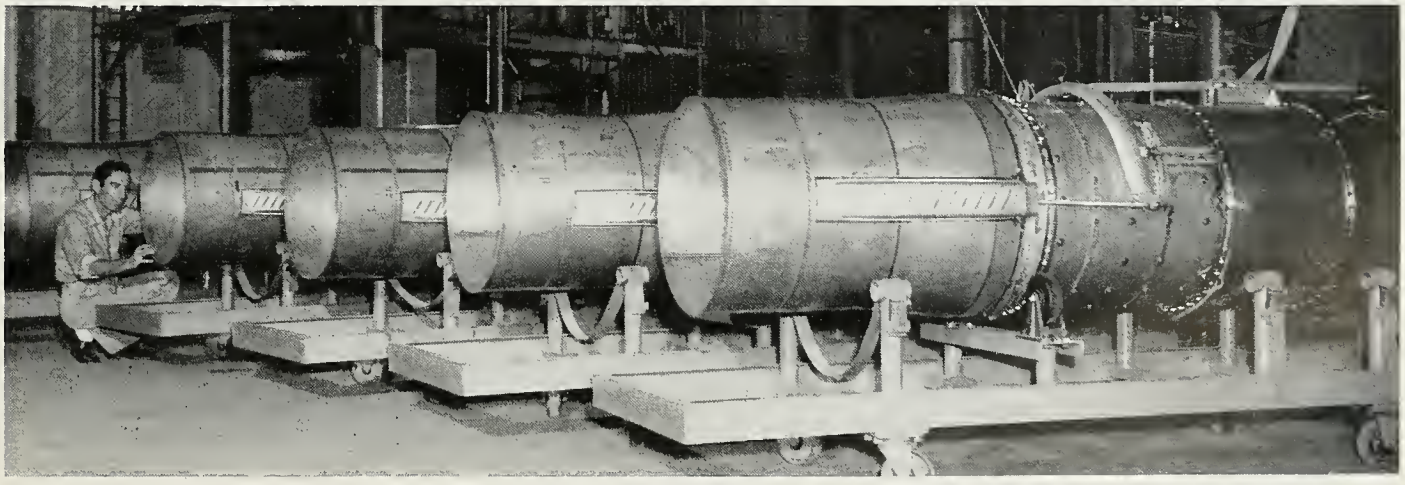
Versatility of the F7U-3 comes from its various "accessories." The fighters and attack planes are fitted with underwing racks for carrying weapons ranging from rockets and guided missiles to bombs and cannon. Auxiliary fuel tanks may replace the weapons when extra range for reconnaissance is needed.

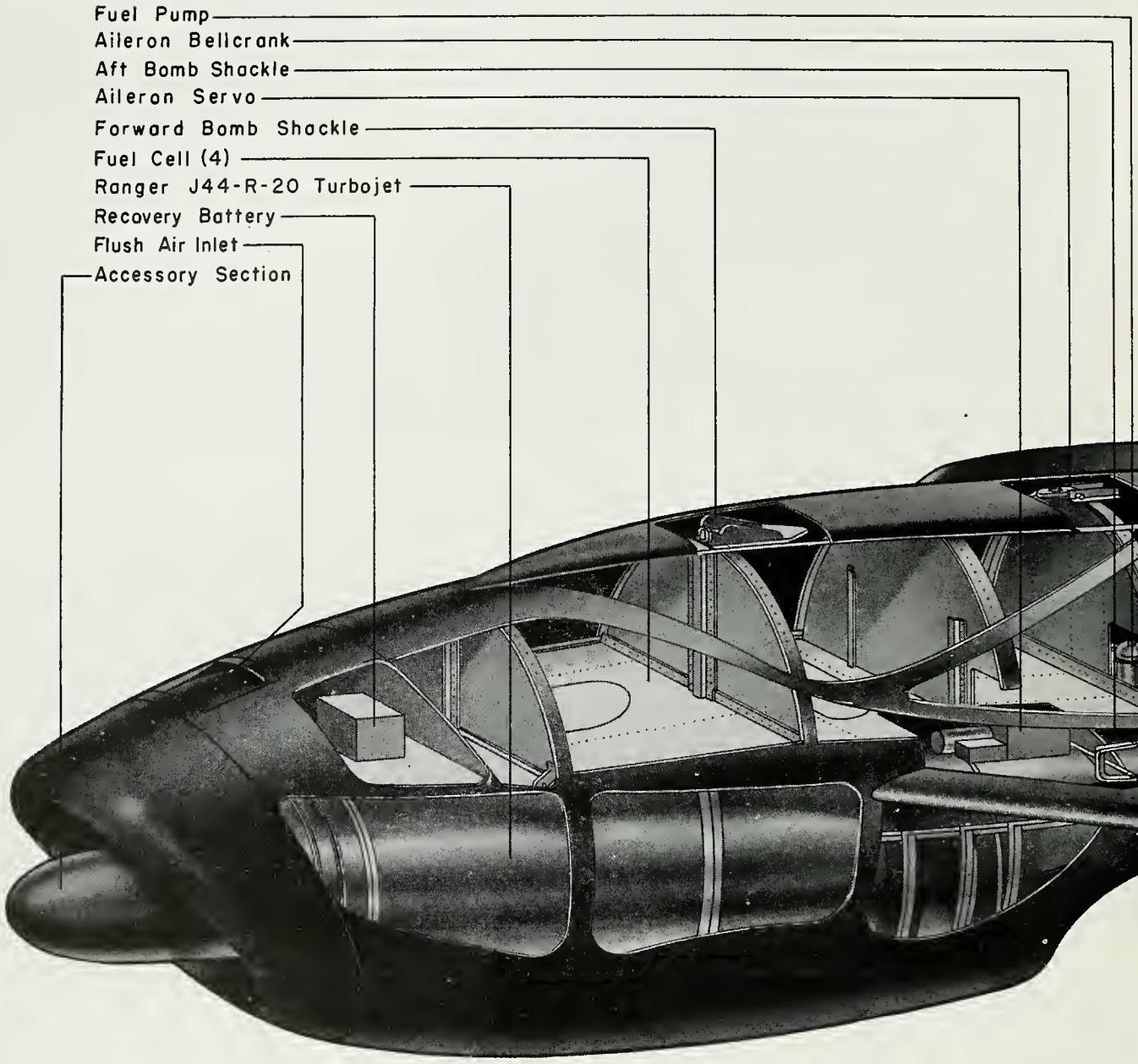
The reconnaissance version also has an elongated nose to hold five camera stations. In fact, the photo Cutlass can emerge as any one of four additional configurations by the simple change of the type of cameras installed, depending on whether general reconnaissance, mapping

(Continued on Page 26)

Striking appearance of the F7U-3 itself is matched by pilot's high-altitude suit.

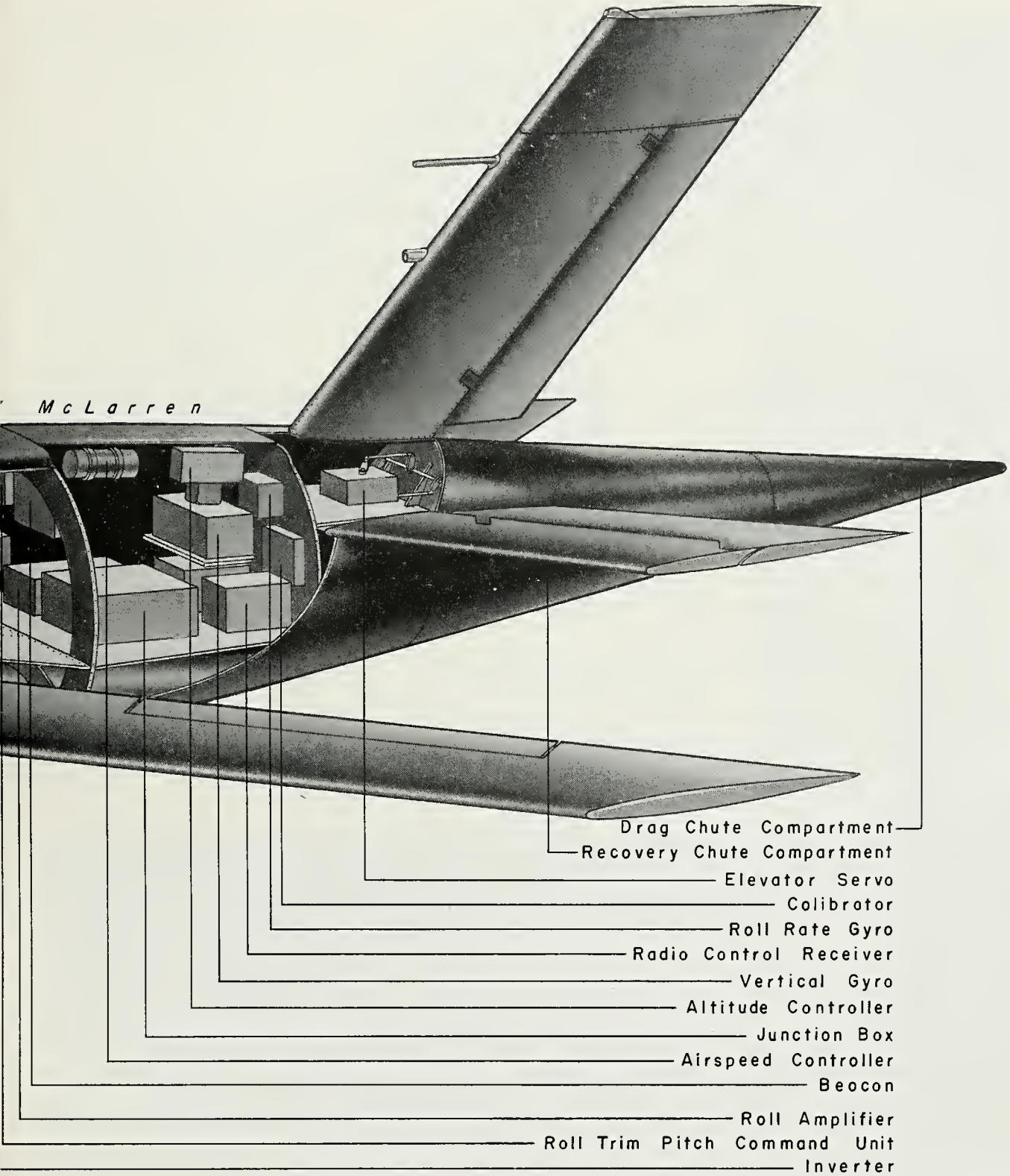
Whopping boost in power for Cutlass' twin J-46 turbojets is made possible by the use of afterburners precision-built by Ryan.





THE RYAN FIREBEE

MODERN weapons require modern targets to challenge fully the skill of jet fighter, guided missile and anti-aircraft crews. Such a target is the high-speed Firebee jet plane, designed, developed and manufactured by Ryan. This advanced-type drone missile is electronically controlled to simulate high performance enemy aircraft, yet is supplied to the armed forces at a fraction of the cost of piloted jets converted to target use. The Firebee can be air- or ground-launched, and is recoverable by a unique parachute system, to be used again and again. In addition to target work it has wide use in the evaluation of new weapons.



Firebee drawing by Robert McLarren reprinted courtesy Aero Digest Magazine.

Ryan's "Firebee" is the only target missile that is as fast and agile as a jet fighter, to sharpen the "sights" of gun and missile crews.

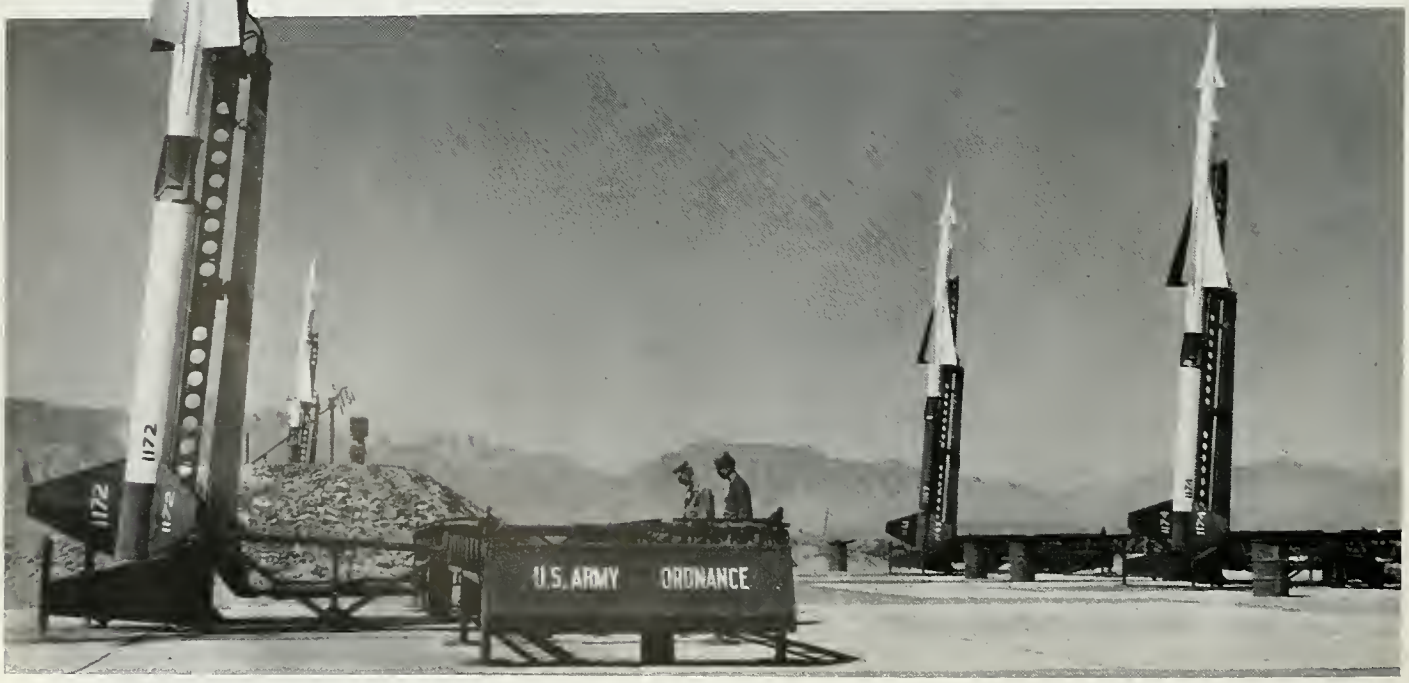
Practice makes perfect, but only when targets simulate enemy aircraft performance to test crews and weapons

TARGET FOR TODAY

Editor's Note: A recent statement in the press concerning development of a "parachute target" failed to make clear that this country has available a high-speed, high altitude pilotless aircraft as a suitable target for training gunnery crews and for the evaluation of new weapons systems. The following article was prepared to give the subject proper perspective.

A SMALL, swept-wing, pilotless jet plane, the Ryan "Firebee," which is capable of simulating attacking enemy aircraft, has been developed as a high-speed, high-altitude recoverable target by the U. S. military services.

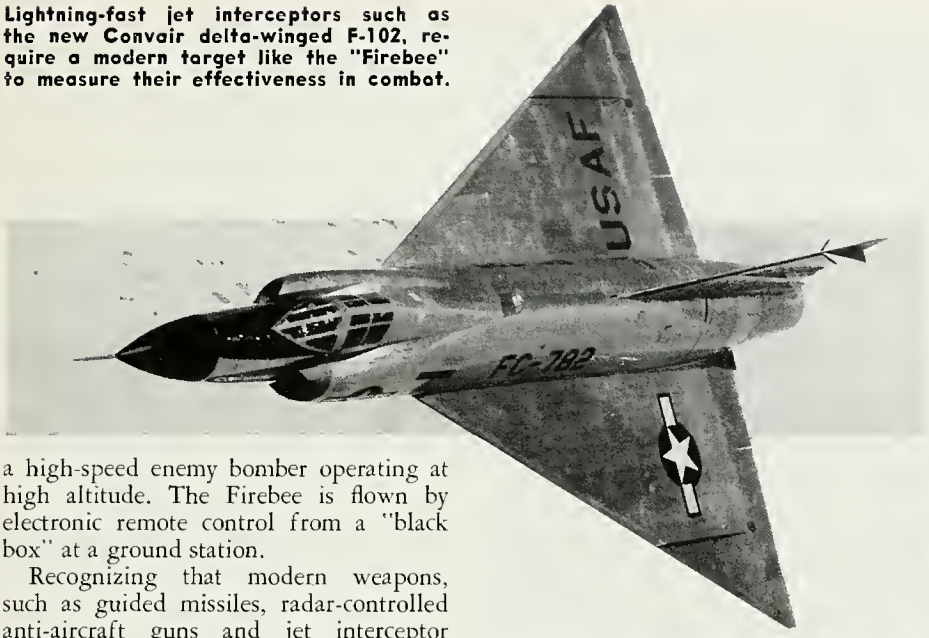
By contrast with targets which have been used in the past, the Firebee jet drone missile is able to fly at speeds of around 600 miles an hour and at altitudes of up to 40,000 feet. It also has the radar-reflectivity required to properly simulate



Official U. S. Army Photo

"Nike," a slender finger of destruction equipped with an electronic brain, locates and destroys enemy aircraft at supersonic speeds.

Lightning-fast jet interceptors such as the new Convair delta-winged F-102, require a modern target like the "Firebee" to measure their effectiveness in combat.



a high-speed enemy bomber operating at high altitude. The Firebee is flown by electronic remote control from a "black box" at a ground station.

Recognizing that modern weapons, such as guided missiles, radar-controlled anti-aircraft guns and jet interceptor planes, require modern targets for crew training, the Air Force, Army and Navy several years ago jointly sponsored development of the Firebee by the Ryan Aeronautical Company. This was done in the realization that proper training is one of the most critical areas of our air defense.

Equally as important as crew training to the air defense program is the evaluation of weapons sytems. Here, too, the Firebee has broad applications. Every new weapon must be tested and evaluated before being put into production. Only by providing challenging targets, such as the Firebee, can the effectiveness of each new device properly be determined.

The inadequacy of the targets which have been used for crew training and weapons evaluation—200 m.p.h. towed sleeve targets, small radio-controlled planes with gasoline engines, and obsolete planes converted to drone operation—has been emphasized by recent gunnery meets. Observers have pointed out that such targets do not instill confidence in crews in their ability to shoot down enemy aircraft because they are unable to simulate the speed, altitude and performance of attacking jet fighters.

Nor, does the recently announced "parachute target" meet this requirement. Fired by a rocket to high-altitude, the parachute target floats down to earth. Because it is impregnated with metal, it offers radar reflectivity for guided missile crews seeking to locate and shoot it down. The deficiency of this system is that the

(Continued on Page 25)

Spotting, tracking and intercepting enemy planes with 75mm Skysweeper artillery gun requires a skill that comes only from training with high performance targets.

Rocket-powered guided missiles must be evaluated by pitting them against fast, maneuverable target like the "Firebee."

This radar set is typical of the electronics equipment which has to be packaged for installation in the small space available in modern aircraft. (Northrop picture.)

THE transition from the 300-mph aircraft of World War II to the 600-mph aircraft of today has not been too serious a problem for the designer of airborne electronic equipment. The next step—to the trans- and super-sonic aircraft of tomorrow—is a change of more serious proportions. Temporarily, designers may be able to keep pace by the use of new components, materials, and processes. It is readily apparent, however, that eventually new engineering techniques and ideas will be needed to overcome the problems associated with increasing complexity and more severe environment. To reach this goal, the electronics designer must work side by side with other engineers and designers. Only in this way can he arrive at an electronics system which is economically feasible, and which provides high performance in the aircraft of tomorrow.

AIRCRAFT ENVIRONMENT—*PRE-WAR*

During the period which ended early in World War II, electronic equipment aboard military aircraft was primarily communication equipment. Much of it had been specifically designed for aircraft, but some was standard commercial equipment installed in any available corner. The environmental requirements for those early days were considerably less stringent than they are today. Landing shocks and vibration were not as severe, and maximum ambient temperatures were reached when the aircraft was on the

(Continued on Page 27)

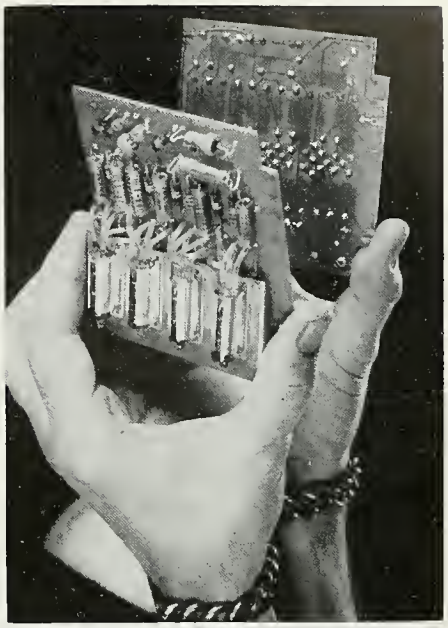
PACKAGED FOR FLIG

"Housing problem" for airborne electronic equipment besets designers, manufacturers

by R. J. Cary, Project Administrator
Electronics Section, Engineering Division
Ryan Aeronautical Company

from a paper presented at Society of Automotive Engineers
Los Angeles Aeronautic Meeting

Two examples of miniaturized electronics tubes are shown here, compared with the larger, radio-size tube on the left. Performing all the functions of the other two, the smallest tube on the right occupies only a fraction of the same space.



Etched wiring reduces the size, weight, cost of this subminiature assembly. The reverse side is shown here in a mirror.

In today's high speed, high altitude planes, more and more of the pilot's functions are taken over by semiautomatic or automatic equipment, most of which is electronic in nature.

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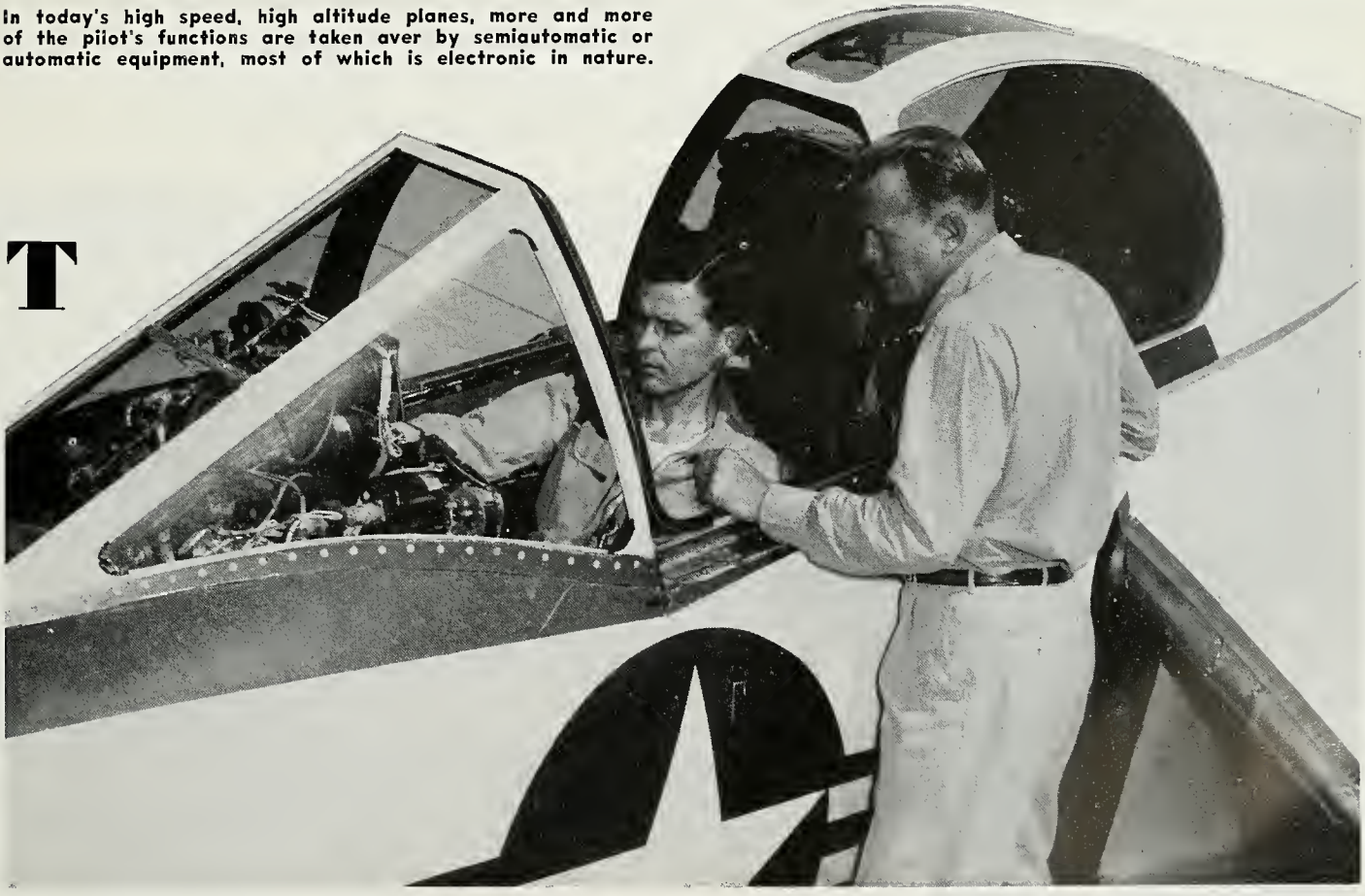
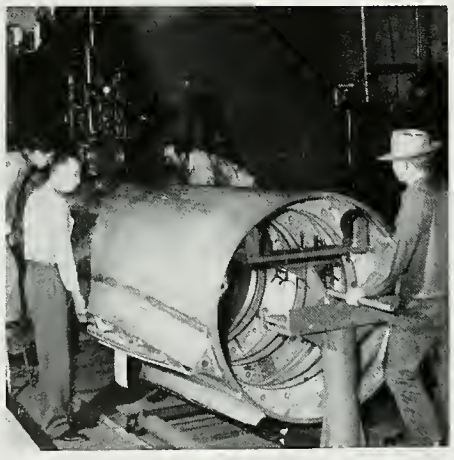


CHALLENGE the job and its details! That is the basic philosophy of Ryan's work simplification program. It's the type of thinking that pays dividends in better methods. From superintendent to the man on the production line Ryan employees are urged to work smarter. They are challenged to ask the five "W" questions about their jobs: the What, Where, When, Who and Why. This approach leads to such queries as "Can my job be done with less effort, less time, less material or less space? Can it be done with less reaching, lifting or moving?" Charged with prime responsibility in this work is Ryan's Methods Engineering Division. One section of the division is devoted to methods improvement work. In each main production area, a methods engineer is assigned to analyze the methods, machines and layout. He makes recommendations to the production superintendent. These men work along three general lines of inquiry. First, they study other industries and plants to visualize how their techniques may be adapted to Ryan. Second, they analyze layouts and machine loadings to improve production and dovetail new products into assembly lines. Third, they encourage the development of conservation suggestions from all of the plant personnel. The other section of methods engineering performs time studies and develops manufacturing control charts. These establish standards of performance for new and improved jobs and show labor hours performed against those budgeted. From these charts, it is possible to get clues about time-consuming operations which lend themselves to method improvement. Without doubt, the man on the actual production line is one of the best sources of new methods ideas. Self-starting meetings are held monthly in all production areas to generate these ideas and keep everyone conscious of the basic philosophy: WORK SMARTER—NOT HARDER. CHALLENGE THE JOB.

OLD WAY . . . . Aligning and spot-welding manifold stamping by hand took 45 minutes, caused high scrap losses.

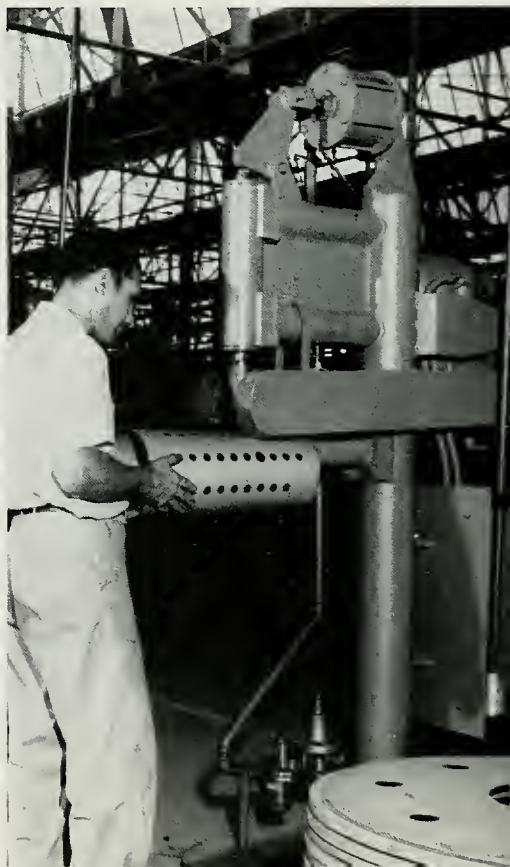
NEW WAY (opposite page) . Arc-tacking stampings in Ryan-built press with Meehanite dies reduced time 25 minutes, scrappage 60 percent and saves $3000 a month.

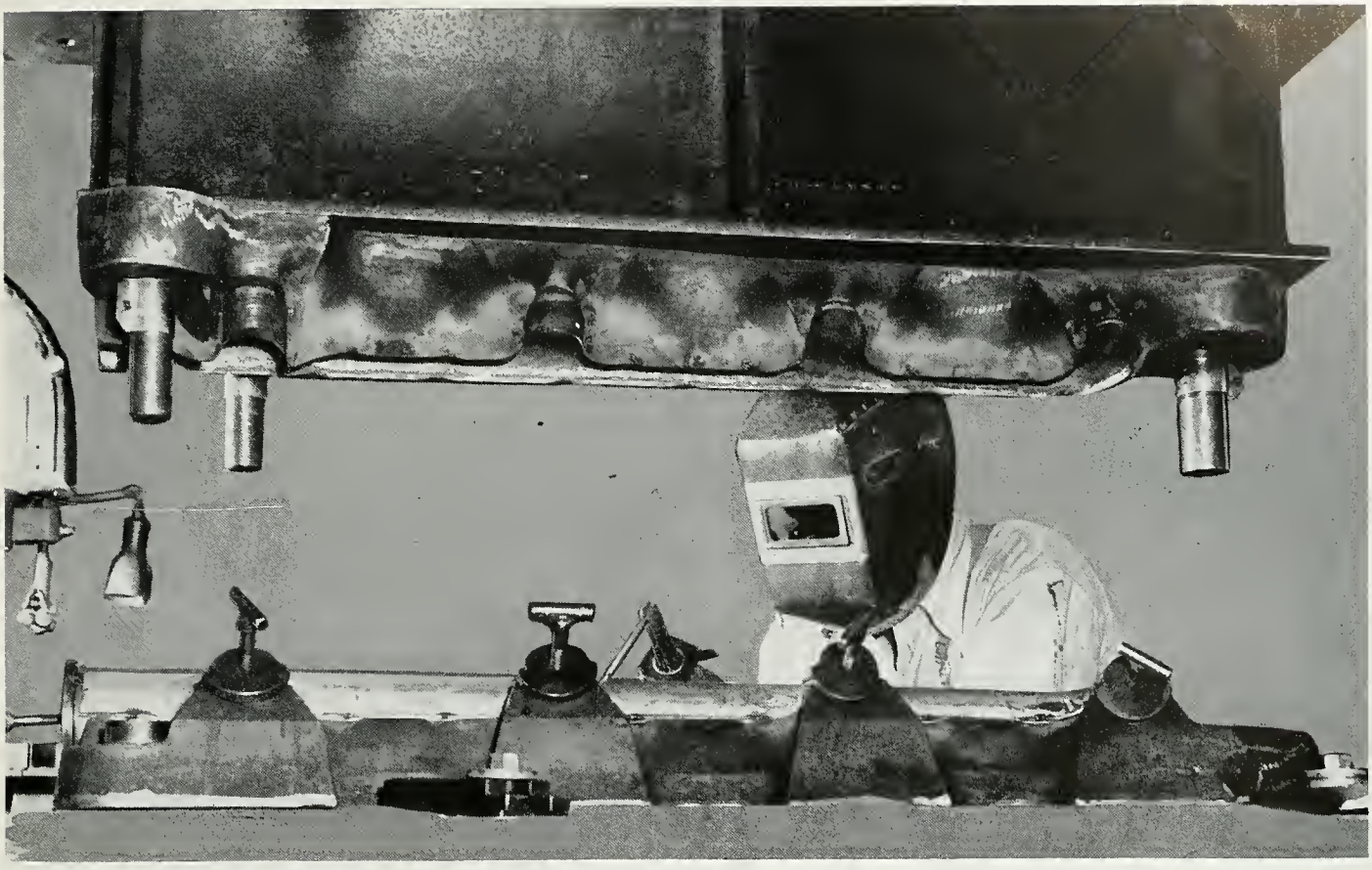
RYAN BUILDS BETTER



OLD WAY . . . . Several helpers are needed to lift large fuel tank so bulkheads will clear spotwelding electrode.

NEW WAY . . . By making electrode rotate, with hydraulic piston and foot control, 10 inches of added clearance are obtained allowing one man to move tank. Designed by Ryan plant engineers.





Every job can be improved by a concerted attack to squeeze the extra effort and waste out of it

OLD WAY . . . . Removing excess metal from the welded seams of tubular sections was a tedious job with air-driven grinder.

←

NEW WAY . . . . Welded seams are rolled flat in one-tenth the time with Ryan-built seam roller which refines grain structure and has a purifying action. Also, use of rollers eliminates need to add filler rod.

OLD WAY . . . . Sharp metal burrs, caused by machining steel exhaust parts were removed by labarious hand filing.

→

NEW WAY . . . . Smooth, steel parts spill from de-burring machines after tumbling with special abrasives. With a large battery of Roto-Finish machines, Ryan saves up to $100,000 a year in costs.

DESERT NIGHTMARE

THE living desert harbors a deadly inhabitant. It's the Army's newest weapon—the "Corporal" guided missile. Peacefully poised among blooming ocotillos, the fearsome destroyer gives no hint of its lethal behavior. Unleashed, the "Corporal" will shiver the desert quiet with its rocket blast as it streaks into space. A hundred miles away, a target can disappear in an atomic nightmare. The power that propels the "Corporal" is a Ryan-built rocket motor. Ryan manufactures these jet motors for Firestone Tire and Rubber Company—producers of the "Corporal." Unlike a fired artillery shell, the "Corporal" can seek out its target after it is launched. This must be done quickly—it travels much faster than sound.

Long line of packaged turbine hoods is towed away from C-46 transport which delivered them from Fairchild Aircraft Co. plant, Hagerstown, Md. to Ryan for rush order modification to bring them up to the latest configuration. Hoods are vital components of turbine nozzle boxes, built by Ryan, and used in new Curtiss-Wright turbo-compound engines which power the Fairchild C-119 "Flying Boxcar" Air Force transports.

SPECIAL DELIVERY FOR SPECIAL RUSH JOB

A typical example of the fast service which Ryan can render to the military services and other manufacturers occurred recently. Fairchild Aircraft Company of Hagerstown, Md., called Ryan's Customer Service Department to ask if a substantial number of turbine hoods could be modified in a hurry. A quick inquiry by the service representatives established that the job could be worked into factory schedules.

Within a few days, a Slick Airways Airfreighter landed at Lindbergh Field, rolled up to the Ryan ramp and began to disgorge the stainless steel turbine hoods. During the following week, more plane loads of turbine hoods arrived from Middletown, Penna., to be modified by Ryan and returned to the Air Force for service.

These components are a vital part of the turbine nozzle boxes used in the new Curtiss-Wright turbo-compound engines which power the Fairchild C-119 "Flying Boxcar" transports for the Air Force. With them, Curtiss-Wright has been able to increase the horsepower of their engines by a full 20 per cent without the consumption of one added drop of fuel. This is accomplished by harnessing the heat energy of the exhaust gases, formerly wasted, and transmitting it back to the propeller in the form of mechanical energy.

Ryan is building large quantities of these turbine hoods for Fairchild and will modify the especially-delivered models to bring them up to the latest configuration.

TARGET FOR TODAY

(Continued from Page 19)

parachute is a "sitting duck" target. Floating down to earth it cannot simulate the performance of a high-speed, attacking enemy plane. The problems of range-finding and tracking a slowly descending parachute target are hardly adequate for the evaluation of the effectiveness of ground-based and airborne weapons against enemy aircraft capable of near sonic speed.

The Ryan Firebee jet drone missile, which is capable of being launched either from "mother" planes in flight, or from the ground, has undergone a long period of development and testing. Currently, Ryan is manufacturing the KDA-1 model of the Firebee at its San Diego plant for the Navy. Flight testing of Navy Firebees is presently being conducted by the Navy's Bureau of Aeronautics at the U. S. Naval Air Missile Test Center at Point Mugu, California.

The U. S. Air Force version of the Firebee, designated Q-2, has been extensively tested at Holloman Air Development Center, Alamogordo, New Mexico, under direction of Wright Air Development Center and the Air Research and Development Command. Ryan recently received a new contract from the Air Force for additional Q-2s.

A quantity of Firebees has been delivered to Army Ordnance where they will be used as targets for the "Nike" ground-to-air guided missile and for training crews operating the new radar-controlled "Skysweeper" anti-aircraft gun. Their version is designated XM21.

"These targets," the Army says, "which fly at almost the speed of sound, are remotely controlled from the ground and can maneuver, at varying speeds and altitudes, over anti-aircraft installations—simulating invading enemy aircraft. In this way, ground troops can gain the experience of operating anti-aircraft guns and guided missiles under near-combat conditions." The Army prefers ground launch as the method of getting the Firebees into the air. A rocket is used to catapult it to flying speed after which the drone missile's jet engine takes over as the sole source of power.

The need for jet targets in the Firebee class was emphasized earlier this year by Rear Adm. Apollo Soucek, chief of the Navy Bureau of Aeronautics, before a House Appropriations Subcommittee. "The increase in the target drone procurement area," he said, "reflects the shift from 200-knot drones to drones in the 400-knot and 600-knot class.

"The 1955 estimate provides an initial quantity of joint service-developed high-

(Continued on Next Page)

speed, long-range drones (Firebee—ed.) to supply the fleet gunnery training program with targets capable of simulating potential enemy attack from out-of-sight ranges.

"Fleet evaluation currently under way . . . is satisfactorily demonstrating their performance characteristics with respect to radar reflectivity, flight endurance and speed."

Justifying an increase in budget figures for this class of aircraft, Capt. Morris A. Hirsch, director of the Bureau of Aeronautics' fiscal division, testified that it "reflects the urgent need for very high-speed drones to more adequately simulate modern aircraft performance."

Approximately 12 feet in span, 18 feet long and weighing 1800 pounds, the Firebee is powered by either a Fairchild J-44 or Continental-Marbore J-69 jet engine developing 1000 pounds of static thrust. These drone missiles are launched either from the belly or wings of a twin-engine "mother" plane, or from rail or zero-length ground launchers. If a hit is scored in gunnery practice, the Firebee's unique two-stage parachute opens to lower it with little or no damage so it can be quickly inspected, repaired and used again as a target.

In its present configuration the Firebee is being evaluated only as a target drone but it has all the attributes of a missile—electronic remote control, no pilot, high-speed jet performance, swept-wing configuration, etc. Its design characteristics are such that it obviously can carry additional payload, which could be used for any item of armament or other equipment within its weight and size limits.

Cost of the Firebee in production is approximately one-tenth that of piloted airplanes converted to pilotless, radio-controlled drones, yet they can be used again and again.

PILOTLESS AIRCRAFT

(Continued from Page 13)

involved. A glance at recent press releases showing launching procedures gives a hint of what this cost must be. Rocket type launchings appear to be the most practical method of getting a missile into the air, partly because it can be done in comparatively small fields. In some high performance missiles we are approaching a thrust-to-weight ratio of one. When this figure is exceeded it may be possible to eliminate the rocket cost by using vertical take-off on the missile engine thrust alone.

These are only a few of the many new problems facing the missile designer and many old ones that are rendered more acute by new requirements and new operating conditions.

Ryan Firebee Project Discussed On Television

The Ryan Firebee, jet target drone plane, was featured Saturday, October 9, in a television presentation on KHJ-TV, Channel 9, Los Angeles, on the Navy public service show, "Seapower For Peace." Forrest Warren, who has been associated with Firebee development for several years as project engineer, is shown at left, with Seaman Gene Gordon, interviewer, as they discuss the swivel used in the drone's parachute release device.

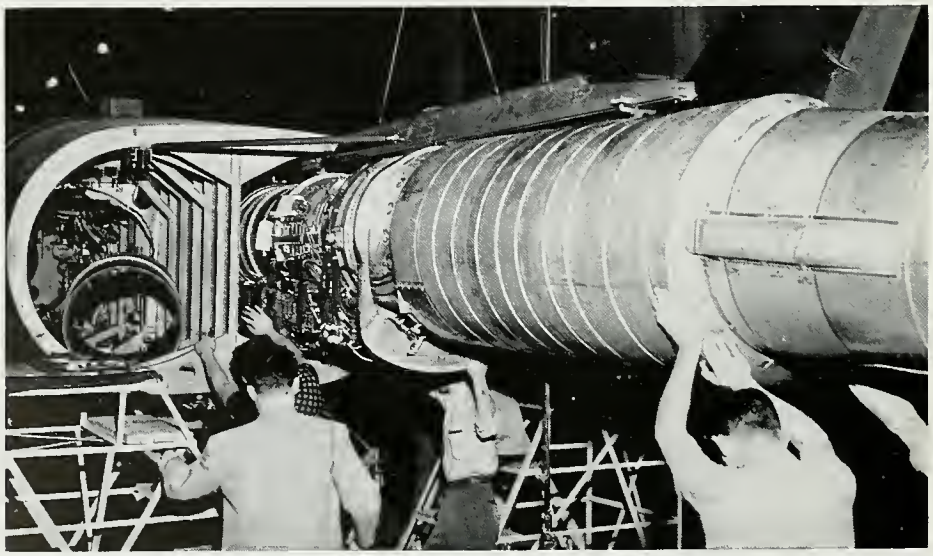
HOT SHOT TWINS

(Continued from Page 15)

and charting, beach and offshore or night photography is involved.

Specialized Navy requirements inspired other unusual features in the Cutlass. For fast maneuvering on tight carrier decks, the F7U-3 fighters have nose wheels which turn 60 degrees left or right of center, controlled from the cockpit by a push-button hydraulic steering apparatus. An in-flight refueling system enables carrier to launch Cutlass squadrons to greatly increased distances, thereby diminishing the ship's vulnerability to attack. Fin-like protuberances on the tail cone permit fuel jettisoning at sea. And leading-edge wing slats replace conventional landing flaps to help the Cutlass achieve the low stalling speed essential for carrier-based aircraft.

In any of its roles, the Cutlass, a real chameleon of the skies, appears to deserve its current spotlighted, "center-stage" position in the modern air arm of the U. S. Fleet.



Chance Vaught crew rolls a powerful J-46 jet engine with attached afterburner into the tail of the Cutlass. A second engine-afterburner unit will be installed on the other side of the unique, broadened fuselage of the versatile new Navy aircraft.

PACKAGED FOR FLIGHT

(Continued from Page 20)

ground. Flights at altitudes above 25,000 or 30,000 feet were unusual.

Manufacturing techniques during this period were governed, to a large extent, by commercial practice. Some manufacturers were beginning to investigate the environment in which their equipment would operate, in order to increase its reliability.

During the early years of the war, the need for a certain amount of standardization became painfully apparent, in connection with stocking and procuring spare parts. The JAN specifications resulted from this need. A good example is the specification for equipment cases, JAN-C-172. Although it was first issued in April, 1954, many equipments manufactured earlier had used the same form factor it specified. In fact, much present-day military and commercial equipment utilizes this form factor.

As the war progressed, the use of electronics increased. Radar and then radar counter-measures became airborne. Compasses, gyros, autopilots, bombsights, fire-control radars, and numerous other devices came into general use. Simultaneously with this increase in the use of electronics, aircraft performance improvements led to an increase in the complexity of control systems. Thus even more electronic equipment was required and a spiral of increasing complexity was generated.

It is difficult to say when this complexity spiral really started, but its effects were felt at an early date. Reliability too, was receiving increasing emphasis. There was little point in designing a plane that could fly 10,000 miles with a full pay load if it had to sit on the ground up to 60 percent of the time because of inoperative equipment.

Most of this operational unavailability could be traced to electronic equipment.

AIRCRAFT ENVIRONMENT— *POST-WAR*

During the years since World War II, the reliability problem has been emphasized by the increasing speed, altitude, and cost of military aircraft. Production aircraft operation at altitudes above 40,000 feet and near-sonic speeds are now realities. The increased use of jet engines in military aircraft has brought many new vibration problems. In this environment the pilot is beginning to be the limiting factor in the operation of the aircraft. More and more of the pilot's functions must be taken over by semiautomatic and automatic equipment, a large part of which is electronic in nature.

What are some of the operations that must be performed by equipment of this type? Let's look at a fighter-type aircraft with an operational ceiling of 40-50,000 feet, and speeds in the near-sonic range. The pilot has a difficult task just flying this aircraft. The designer tries to help him out by installing a tail-attack warning device of some kind to keep track of what is going on around him. This could be a simple proximity indicator, or an elaborate automatic acquisition, tracking, and fire-control set. Because the pilot's reactions are relatively slow, special control systems are necessary to correct flight altitude automatically. Systems of this type usually require a considerable amount of hydraulic or electric power for their satisfactory operation. To handle this extra load, the basic power source in the aircraft must be larger and as a consequence, the aircraft propulsion plant must be enlarged. More fuel must be carried to maintain the same operational range. The added fuel requires larger fuel tanks, thereby adding still more weight. With few exceptions, as the engine and aircraft got larger, they also became more complex.

What has been done by designers and manufacturers to mitigate this problem of complexity and reliability? Both groups are working on ways and means to reach a satisfactory solution to this problem. You may remember the problem faced by the airlines several years ago with tube failures in their airborne equipment. They got together and formed Aeronautical Radio, Inc., which was organized specifically to gather data about failures in order to find ways of minimizing them. Their work was successful. I believe all of the improved tubes developed by ARINC now appear on the military list of preferred tubes.

Reliability improvement is directly connected with electronic equipment packaging. Although both the amount and complexity of the equipment installed in aircraft increased, the installation space available for this equipment did not increase proportionally. This raised the problem of effective miniaturization of the equipment. The component manufacturers, realizing this trend, had been hard at work making their products smaller and more reliable. However, smaller size was not the only goal. It became necessary to have components capable of withstanding higher temperatures, since it was difficult in many cases to decrease the dissipated electrical power proportionally.

The size decrease aggravated another entirely different problem—equipment maintenance. As parts density grew, it became increasingly difficult for service technicians to repair equipment in the normal manner. This was one of the factors which motivated unitized construction —small subassemblies that could be easily replaced with new subassemblies and then discarded or repaired at some later date. While there may be valid objections to the trend toward unitized construction, it is evident that present-day equipment complexity requires that the maintenance be simplified to the greatest extent. There are several reasons for this. First, equipment complexity puts a severe strain on the military maintenance technician and his training. Second, there is the supply problem, especially in the field. It is not possible for advanced units to carry spare parts to cover every eventuality. If the equipment is divided into easily-removable subassemblies, not only are fewer spare items necessary but their replacement is simpler, with consequent reduction in equipment "down" time. All things considered, it is economically feasible, in almost any military situation, to use unitized equipment in preference to standard equipment.

How does equipment complexity relate to aircraft environment? As the aircraft environment becomes increasingly severe, the instrumentation to accomplish the basic mission of the aircraft becomes increasingly complex, primarily because of the necessity for automation of many functions previously performed by the pilot.

The term "equipment complexity" may have several meanings. To the designer and technician it may describe a highly intricate piece of equipment which has thousands of individual parts—in other words, circuit complexity. To the operator, complexity can take on an entirely different meaning. If an equipment or system is easily operated, and will perform satisfactorily every time it is called upon, with a minimum of maintenance, then to him it is simple and reliable regardless of how many parts it contains. This definition may be thought of as operational complexity. Reliability and simplicity usually go hand-in-hand. "Simple equipment is reliable equipment" is a phrase that should be in the mind of every designer and engineer. Many engineers can design a complex piece of equipment to do a given job, but it takes ingenuity to develop a simple piece of equipment which can do the same job.

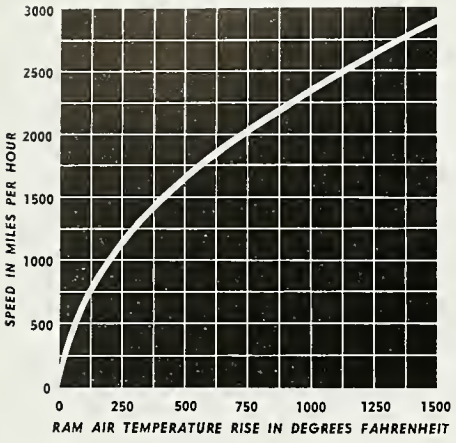
AIRCRAFT ENVIRONMENT— *FUTURE*

It is common knowledge that the services are testing developmental aircraft with speeds up to 1500 mph. What effect

(Continued on Next Page)

will aircraft speed in this range have upon the physical environment of the equipment and its configuration?

The first obvious effect is that of heat. Chart illustrates ram air temperature rise plotted against true airspeed. It should be noted that this rise must be added to the ambient temperatures. Assuming a speed of 1500 mph at sea level on an Army standard summer day (100° F ambient), the skin temperatures at leading edge surfaces would be in the uncomfortable region of 500°F. (260°C)!



Not only do we lack, at the present time, the materials necessary to make electronic equipment perform all the required aircraft functions at this temperature, but the operating personnel could not exist in such an environment

The other major effects of high-speed flight—shock, acceleration, and vibration —are primarily limited by aircraft design. Here again, operating personnel become a limiting factor. Because of the extremely high rotor speeds of modern jet engines, vibration frequencies as high as 1500-2000 cycles are not uncommon. This poses entirely different mechanical design problems for the equipment designer.

Given the major problem of providing suitable equipment performance at the higher temperatures created by supersonic flight, what methods may be used to arrive at a solution? The possible solutions may be divided into two basic types. Equipment may be designed to operate directly in the high-temperature environment, or else the environment may be modified locally to permit satisfactory equipment operation. Both of these methods have been tried on a development basis in recent years with varying degrees of success.

Certain electronic equipment which can operate in ambient temperatures above 150°C (302°F) has been developed, and work is progressing toward a goal of 200°C (392°F) or higher. The progress of this type of development is obviously limited by the availability of components and materials. It should be remembered that the temperatures discussed have been ambient temperatures, and that there are additional temperature rises. At an internal equipment temperature of 250°C, we are fast approaching the upper temperature limitations of glass vacuum tubes, except for very short-life operations. This means that other heat-resistant materials, such as ceramics, will have to be used to a greater extent. The art of designing for good heat conduction, dissipation, and transfer must be highly developed to take maximum advantage of the temperature differential between the heat source and the ultimate heat sink. Operation at extremely high altitudes (above 60,000 feet) often requires placing electronic equipment in a pressurized portion of the aircraft, unless the equipment itself has been hermetically sealed. Pressurization or sealing is important for two reasons. One is a decrease in voltage breakdown ratings and the other is the decrease in cooling efficiency of air at low atmospheric pressures.

When the internal aircraft environment must be modified to provide an area suitable for the operation of electronic equipment, the limitations of the equipment must be as close as feasible to the actual aircraft environment. Actually the success of this second solution is somewhat dependent upon the first method, since there are definite advantages in minimizing the alteration of the aircraft internal environment. By proper utilization of the cooling system used for the crew, the space and weight required for cooling the electronic equipment may be kept to a minimum.

Unitized equipment can be a large part of the answer to the production and maintenance problem. I say can be, because, unless the equipment designer makes full use of all the advantages of unitized construction, the results may be far from satisfactory. The advantages of unitization may occur at several stages of equipment life. Maintenance trouble-shooting and preventive maintenance are simplified, because of simpler test equipment and easier part replacement. Technician training can be minimized accordingly. Spare parts procurement and stocking are eased because of the smaller number of parts to be handled. Unitized equipment can be produced at a higher rate because the subassemblies are smaller and easier to handle. The subassemblies can be made readily adaptable to automatic production. Equipment design changes, both during and after production, are more easily accomplished by simple subassembly substitution. Certain subassemblies may be standardized for use in similar equipment. Because individual units are smaller, the module dimensions may be easier to determine.

While the preceding advantages show that much may be gained by unitization, certain possible disadvantages must also be considered. The use of additional inter-connection components could decrease reliability. Problems of circuit interactions, additional circuit losses, and heat dissipation are very real. These factors can be mitigated, however, by careful attention during the equipment design phase. The loss of one component in a subassembly could mean the loss of the entire subassembly, unless the construction provides for detailed part maintenance. Equipment development costs would probably be increased.

It should be noted that many of the disadvantages may be compensated by advantages. For example, the increase in total equipment costs, as well as possible increase in spare parts cost, may be offset by the decreased maintenance cost and equipment down time. In future equipment design the necessity of optimizing the number of subassemblies in the equipment with relation to unit cost, ease of replacement, size, complexity, and reliability will become increasingly important as the volume of equipment in use increases.

In the face of increasing electronic equipment complexity, the services still have the problem of maintaining this equipment with practically the same level of technical personnel. Therefore it is up to the design engineer to insure that the equipment is as reliable and simple to maintain as possible. While 100 percent reliability is a goal towards which we are all working, we should be realistic. We know that it cannot be obtained in the equipment now coming off the production line or even off the drafting boards. On the other hand, the maintenance problem can be minimized by careful attention during the equipment design period. The incorporation of test circuits directly into the equipment itself is probably one of the best ways of minimizing the maintenance problem. This must be done, however, without adding appreciably to the complexity of the basic equipment. A possible method is by utilizing, to the greatest practical extent, the equipment circuitry itself. In order to simplify tactical maintenance, the test results should be on a good-bad basis. A simple program of preventive testing may then be set up for equipment of this type. This would provide practically uninterrupted operational availability. Some of these advantages can be gained only at slightly higher cost. For example, the cost of

(Continued on Next Page)

New U. S. Air Force Contract Boosts Ryan Electronic Work

The expanding electronics work of the Ryan Aeronautical Company was given another boost recently with announcement by T. Claude Ryan, president, that the U. S. Air Force has awarded the company an additional contract for missile guidance system equipment developed by Ryan.

Ryan is currently working in three fields of airborne electronics—guidance systems, navigation systems and helicopter hovering devices—under Air Force and Navy contracts totaling approximately $5,000,000. Additional electronics work for the military services is now being negotiated, Ryan said.

A pioneer in the field of development of continuous wave radar techniques for missile, aircraft and rotary wing applications, Ryan made its first major contribution with the target seeking system for its "Firebird" air-to-air research missile.

In addition to flight testing of Ryan electronics devices in its Firebird, the company has also flown its systems in the Ryan "Firebee" jet drone missile, and in helicopters, Navy P2V Neptune bombers and Air Force F-86 Sabre fighters. Test work has also included the use of B-47 Stratojets and other late-type aircraft at Edwards Air Force Base and various Navy aircraft at the Naval Air Development Center, Johnsonville, Penna. and Patuxent River, Maryland.

An Air Force T-33A two-seat jet trainer will be assigned to Ryan and operated by company flight personnel in connection with the latest Air Force contract. The T-33A will be equipped with special wingtip pods to house the Ryan electronic gear.

PACKAGED FOR FLIGHT

(Continued from Page 28)

spare subassemblies will undoubtedly be more than for the equivalent individual parts. This consideration should be offset by the saving in maintenance time.

PROJECTIONS—*EQUIPMENT*

The electronic complement of each new aircraft of the future will be peculiar to that aircraft, so it probably will no longer be feasible to use a particular system in more than a few different types of aircraft without changing the equipment configuration. The practice of designing an aircraft and then placing the electronic equipment wherever there happens to be available space is not valid with the increasing complexity of high performance aircraft. Every cubic inch must be utilized to the greatest possible extent, and equipment repackaging will often be necessary.

Several basic types of equipment configuration have been fairly well explored in recent years. An outstanding example is the modular rack type of construction. This configuration presupposes that nearly all the electronic equipment carried on the aircraft can be packaged in certain module dimensions. The module, or subassembly package, would be determined on the basis of the factors previously discussed, i.e., size, weight, cost, complexity, reliability, and maintenance. The cooling of such a configuration could be accomplished in several ways, depending upon the aircraft types and mission. A so-called "cold-plate," for conducting cooling, would probably be used. Details of various cooling systems proposed for a modular installation have been discussed and published at recent conferences and in current literature. By suitable design of each module and the cooling system, the additional cooling required from the aircraft system may be minimized. The combined modular equipment and cooling system would weigh very little more than the typical present-day electronics installation.

(This article was presented by the author to the S.A.E. AERONAUTIC MEETING in Los Angeles, October 5-9.)

INDUSTRIAL AMBASSADORS

(Continued from Page 2)

in 1937, and came out in 1938 as a second lieutenant. After four years' service at Convair, he performed World War II functions as a civilian inspection supervisor in the Navy, where his assignments included supervision of inspection at the Sand Point Naval Air Station assembly and repair department.

The Wright Aeronautical division of Curtiss-Wright Corp. also has comprehensive representation at Ryan, where important work is under way on J-65 jet components, the J-65 afterburners, and nozzles for the Wright turbo compound engine.

Four men have been assigned to this area, their responsibilities varied. Pat Raftery is concerned with purchase functions, Wayne Pangborn is resident engineer, and Paul Di Lella and Henry Jin are resident inspectors.

With the volume of work for Pratt & Whitney Aircraft increasing, that firm assigned Irving E. Lundin to Ryan early this year. He is a control metallurgist who has established what is termed as "source inspection" in the Ryan plant to assure acceptance before shipment. Ryan's majors contracts for Pratt & Whitney Aircraft are the exhaust manifolds on the "4360" piston engine, and components for the powerful J-57 jet engine. Lundin has established himself in an office in the receiving inspection department.

Ryan is manufacturing the high-powered engines for the "Corporal" rocket under contract with Firestone Tire & Rubber Company, which is represented by J. J. Patterson. Since his home office is Los Angeles, he is able to visit his headquarters more often than most of the other representatives. Despite the fact that prime contractor and subcontractor are only 120 miles apart, Firestone finds it advantageous to maintain a full-time representative at Ryan, sole supplier of its rocket engines.

Newest representative at Ryan is Francis P. Burke, who recently was assigned to Ryan by the Ford Motor Co.'s Chicago plant, builders of the J-57 engine under license from Pratt & Whitney Aircraft. Ryan is a principal supplier to Ford, as well as Pratt & Whitney Aircraft.

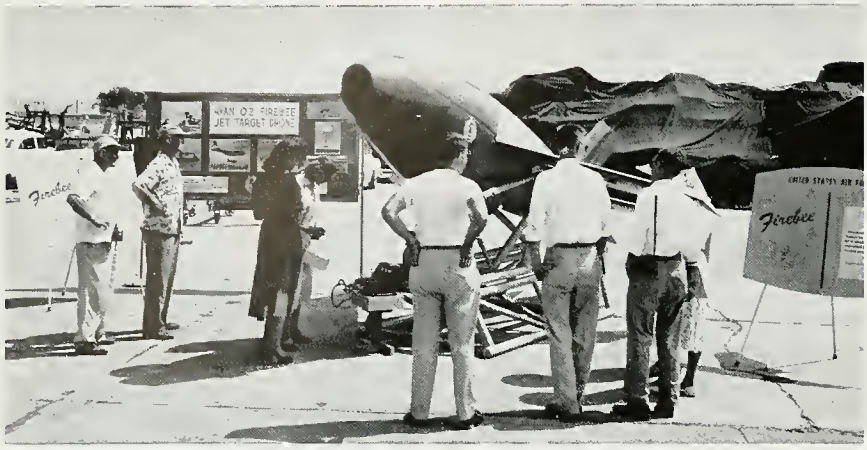
The increasing tempo of Ryan output for Ford has established the need for a quality control representative to work with Ryan inspectors. Occasionally, to further enhance coordination between the two factories, specialists from the Chicago plant are dispatched to San Diego for brief periods.

Some customers maintain their West Coast headquarters in Los Angeles. In that category is Westinghouse Electric Corp.'s aviation gas turbine division, of Kansas City, whose West Coast delegate, A. H. Stone, Jr., visits Ryan once a week to check on progress in the quantity production of afterburners for the J-46 jet engine.

Essentially, the customer representative's job is to make sure that deliveries are performed on time.

"We can do that," one of them summed it up succinctly, "by intercepting most of the problems before they get out of the door."

Firebee Occupies Spotlight In National Air Show



The Ryan Firebee pilotless jet target drone project occupied the spotlight at the recent National Air Show in Daytan, O., where an exhibit featured one of the drones, its remote control apparatus, and a display baard showing various means of launching the craft, the plane in flight, and parachute recavery sequence. Phata at tap shaws exhibit at Daytan. Display baard is viewed, in phata belaw, by Edith Larsan and H. E. Harrisan, Ryan emplayees, before it was shipped east.

Ryan Firebee Features Navy Float In Parade

A Ryan Firebee was featured in the float entered by the Pt. Mugu Naval Air Missile Test Center in the recent Leman Festival parade at Santa Paula. A testing program of Navy Firebees, designated the KDA-1, has been started at Pt. Mugu.

ACCENT ON TOMORROW

(Continued from Page 4)

the equipment needed to perform a specific military mission. Development and production is scheduled so that all components of the system are available when the system is scheduled to go into use.

Such a weapons system, as defined by the Air Force, consists not only of the airframe and numerous items and types of airborne equipment that are designed to fit into it, but also includes all of the ground handling equipment, training equipment, personal equipment, and all of the logistical support needed to make and keep the system operational. Every pertinent factor that can be anticipated is taken into account when a new weapons system is planned.

All the technical skills of modern science and technology are employed in the design and production of such a system. In the case of one strategic heavy weapons system now being produced for the Air Force, scores of manufacturers are under prime contract to the government to produce components for the system. In addition to these prime contractors, literally scores of thousands of sub-contractors also make their contributions.

Obviously, the development of a major air weapons system represents a substantial expenditure of time, effort and dollars. In order to shorten the development cycle and obtain more air power per tax dollar, ARDC has developed the following procedure for handling new weapons development.

As the first step, the Office of Development Planning under the USAF Deputy Chief of Staff for Development, working jointly with ARDC and consulting with scientific and industrial groups, prepares a Development Planning Objective (DPO), which describes the capabilities of the air weapons required to support the combat missions of the Air Force. The DPO looks 5 to 15 years into the future and broadly expresses the kind of weapons systems that may be technically feasible; a consideration of the estimate of the enemy's probable capabilities; and the time when the objectives must be met to assure technical superiority over the enemy.

After approval by the Air Staff, the DPO is utilized by ARDC to set up development programs for long lead-time items, such as bombing and navigation systems, engines and electronic fire control systems.

The development of a specific weapons system is initiated by a General Operational Requirement (GOR), published by the Director of Requirements in the Air Staff. This document specifies the

(Continued on Next Page)

military problem that USAF wants solved and requests ARDC to solve it. Included in the GOR are such factors as: types of missions the system must perform; types of targets it must attack; the environment in which it must operate; the enemy capabilities it must surmount; and logistical requirements and limitations.

ARDC then reviews the GOR and establishes development policy and guidance in the various technical areas to be explored as possible solutions to fulfill the requirement. Based on its review, ARDC calls on industry to study approaches to the operational problem involved and contracts for one or more General Design Studies of a weapon system proposed to fulfill the requirement.

Joint ARDC-industry study and research on the problem eventually produces what is known as a Development Plan —a step-by-step development schedule for the entire system and its major components. If approved by the Air Staff, it is referred back to ARDC for execution. ARDC, in turn, assigns responsibility for the development to a particular ARDC Center and a Phase 1 development contract is awarded to a contractor to begin the system development.

To accomplish the weighty managerial job involved in the scheduling and time-phasing of the thousands of components that compose a modern weapons system into an integrated development and production program, ARDC utilizes the management ability of industry. Weapons system contractors manage the development of individual weapons systems, while the Air Force continues to guide the development program as a whole.

One such weapons system contractor is the Ryan Aeronautical Company, which already is at work under recently awarded weapons system management contracts giving the company full responsibility for all phases of new aircraft development.

In addition to applied research and development, ARDC supports an extensive program of basic research in universities, foundations and industrial laboratories. Purpose of this type of research is to advance fundamental knowledge in the areas of science where there is a reasonable expectation of eventual use by the Air Force in future developments. As contrasted to applied research, basic research is not aimed at fulfilling a definite requirement that exists. Rather, it is directed toward the development of basic understanding in the physical sciences.

Ten major research, development and test centers maintained and directed by ARDC headquarters play a dominant role in the global battle for technical leadership in the air.

WEATHER COATED

Protection against the elements is being provided the increasing quantity of inactive jigs, fixtures, kirksite dies and plaster patterns which must be stored outdoors.

An extensive program of preservation has been started under direct supervision of E. R. Akey, of factory special assignments, who reports to Floyd Cox, manager of production engineering.

Prevention of "weathering" will reduce the amount of labor needed in reworking tools that are restored to service from the inactive group, Akey pointed out.

Grease and rust are removed from steel articles, on which is then applied a phosphoric compound to prevent rusting while awaiting application of the topcoating preservative. In the past, preservative greases were used, but have not proved as effective as desired. A lacquer coating used on plaster patterns or mockups also did not resist outdoor conditions.

The preservative now being used is a plastic or resin type film that has shown favorable characteristics in tests.

Robert B. Sharon applies preservative with spray gun on C-124 jig placed in the inactive pool behind paint shop.

Plaster mockup of C-97 pod assembly is given topcoating preservative by J. R. Barrera to prevent its deterioration in outside near the east end of the plant.

JET TANKER SUB-CONTRACT

(Continued from Page 6)

July 15, 1954.

The new Boeing tanker-transport will be used to refuel the eight-engined B-52 and other jet bombers in the air, thus extending the Strategic Air Force's command of the skies to virtually any danger spot in the world.

More than 650 aft fuselages have been produced by Ryan since 1949 for the piston-engine Boeing C-97 Stratofreighter and KC-97 tanker for midair refueling.

In addition, Ryan has been building the cargo doors, the pod in which the operator controls the midair refueling boom, the floor beams, the external wing fuel tanks which provide the KC-97 itself with added range, and the exhaust systems which Boeing installs to handle the hot engine gases from the four Pratt & Whitney piston power plants.

Ryan's partnership with Boeing in the production of the C-97 and KC-97 has helped make possible what is believed a new record for military aircraft of any type. Output of the double-deck, 350-mile-an-hour planes has been on schedule for more than 60 consecutive months with only one break, in December 1950, when the quota was missed by a single plane.

Assistant Navy Secretary Visits Ryan

Assistant Secretary of the Navy for Air James H. Smith, second from left, recently visited the Ryan plant and was brought up to date on the company's advanced new projects for the Navy, including an airborne navigation system, and the KDA-1 Firebee jet drone target plane. Smith also inspected another project on the confidential list. He is shown here with Vice Adm. Harold M. Martin, commander Air Force Pacific, at left, conferring with T. Claude Ryan, president, center, and Bruce Smith, director of engineering.

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TURBOPROPS

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transmitted through a shaft to drive the compressor, and through a high ratio reduction gear to drive the propeller. The exhaust gases which are ejected rearward give some added thrust—the ratio being about 80 per cent propeller thrust and 20 per cent jet.

The turboprop engine isn't a "Johnny-come-lately" to aviation. Historically, the first flight in the world of a turboprop-powered airplane was made in this country in 1945 by the Convair XP-81. Developed for the Army Air Force, this aircraft was powered by a General Electric TG-100 turboprop engine operating in conjunction with a General Electric I-40 (later Allison J-33) turbojet, which was installed in the aft section of the fuselage.

Ryan Aeronautical Company pioneered the use of turboprops in the Navy with the development of the revolutionary XF2R-1 "Dark Shark," the second turboprop plane to fly in this country. Powered by a General Electric TG-100 turboprop in the nose and a General Electric I-16 turbojet in the tail, the XF2R-1 had the distinction of being the first turboprop plane to make a cross-country flight. It was a modified version of the famed Ryan FR-1 "Fireball" series, the first planes in the world to combine reciprocating engine power with jet propulsion and the Navy's first jet fighters.

America's first turboprop transport—the Convair-built Allison-Turboliner—made its maiden flight in 1950. Powered by two 2,295 hp. Allison T38 turboprops, it is now on an extensive demonstration tour designed to acquaint military, industry and press representatives with the advantages of the turboprop powerplant.

The recent first flight of Lockheed's YC-130—the first Air Force transport designed from the outset for turboprop power—foreshadows the day when the United States will have an all turbine-powered fleet of transports in support of its all turbine-powered combat force. Meanwhile, to expedite turboprop development, a special six-plane Military Air Transport Service squadron is soon scheduled to begin a turboprop service test program, using standard aircraft which have been modified to take turboprop engines.

Aircraft assigned to this program include: two Boeing YC-97Js, powered by four 5,500 hp. Pratt & Whitney Aircraft YT-34s; two Convair YC-131s, equipped with two 3,750 hp. Allison YT-56 engines; and two Lockheed YC-121Fs, using four Pratt & Whitney Aircraft YT-34s. With the nation's airlines invited to participate, the Air Force will fly the planes in routine domestic cargo operations, carrying military equipment to installations within the United States. Purpose of the program is to accumulate engine flying hours in routine operations to aid in the development of the turboprop engines.

By far the most unusual of the turboprop aircraft currently flying in this country are the vertical take-off fighters developed by Convair and Lockheed. Powered by Allison YT-40-14s, the Convair XFY-1 "pogo stick" and the Lockheed XFV-1 are attracting world-wide attention as they continue their flight tests. Allison T-40s also power Convair's famous R3Y "Tradewind" series of four-engined, water-based military transports and the Douglas A2D "Skyshark" Navy attack bombers.

Probably the lightest plane in the world to fly with a turboprop powerplant is the Cessna XL-19B, which flew for the first time in 1952. Powered by a Boeing XT-50-1 turboprop (an adaptation of Boeing's basic model 502 gas turbine), the XL-19B established a new world's lightplane altitude record of 37,063 feet last year. Boeing 502 gas turbines have also been tested in a standard Kaman HTK-1 helicopter.

Increased use of the turboprop in experimental and production type aircraft, such as these, should provide industry and the military services with the operational experience they need to push development of the engine. A record of good performance could lead to a widespread and aggressive development campaign.

It is still too early to resolve the long-standing argument concerning the relative merits of the turboprop and turbojet in the transport application. Studies have shown that the turboprop is by far the most desirable powerplant for transport on the basis of cost per ton-mile. On the other hand, the turbojet has received the most development work, is cheaper to produce and has a decided advantage from the standpoint of maintenance.

The consensus of opinion: both are needed, both will be used.

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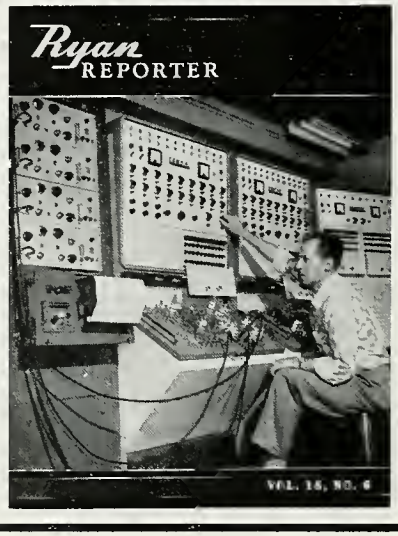
ON THE COVER

John Roth puts a Ryan robot to work by plugging in an analog computer. No clanking, stiff-legged monster, this robot solves problems at lightning-like speed.



Diamond Jim lived like a prince . . . but you live better

With thanks to Norfolk and Western Railroad for the drawing and idea

IN his time, half a century ago, "Diamond Jim" Brady was the envy of every man. To the average person, he was the epitome of luxury. He lived the life to which every ambitious breadwinner aspired.

But "Diamond Jim" Brady lived crudely and uncomfortably, by modern standards. Compared to the possessions of the typical American family today, he was a piker.

This man of fabulous wealth and luxurious tastes never experienced air-conditioning, electric refrigeration, radio, television, high-powered automobiles, transportation by air, fluorescent lights, vitamin tablets, or the amazing variety of products made from plastics. His life expectancy was considerably shorter—47.3 years to today's 68.4 years.

"Diamond Jim" Brady lived in a time when the American people were just beginning to learn how to put to the most efficient use the tools that were to usher in the era of abundance—abundance of homes, automobiles, television sets, clothing, good food.

Today we know that the more we produce efficiently, the more there is for every family to share. America is the world's most productive nation, and therefore enjoys the highest standard of living. There are more things to enjoy—and more time to enjoy them—than in "Diamond Jim" Brady's day because we have developed a system by which fewer hours are required to make more products for everyone.

Unlike half a century ago, ownership of the tools of production is widespread. The continuing need for new tools is met by the desire of Americans to buy them, through the incentive to investment offered by profit-yielding stocks and bonds. An American worker is likely to participate in the ownership of the very tools that provide his livelihood. He has invested in their purchase because of the prospect of reward for temporary self-denial in diverting part of his earnings from consumer goods that would have given him immediate comfort and pleasure.

Investment with a prospect of profit, and high productivity at low cost—these are the twin factors that have placed the average American on a living plane far above the richest man of "Diamond Jim" Brady's day.

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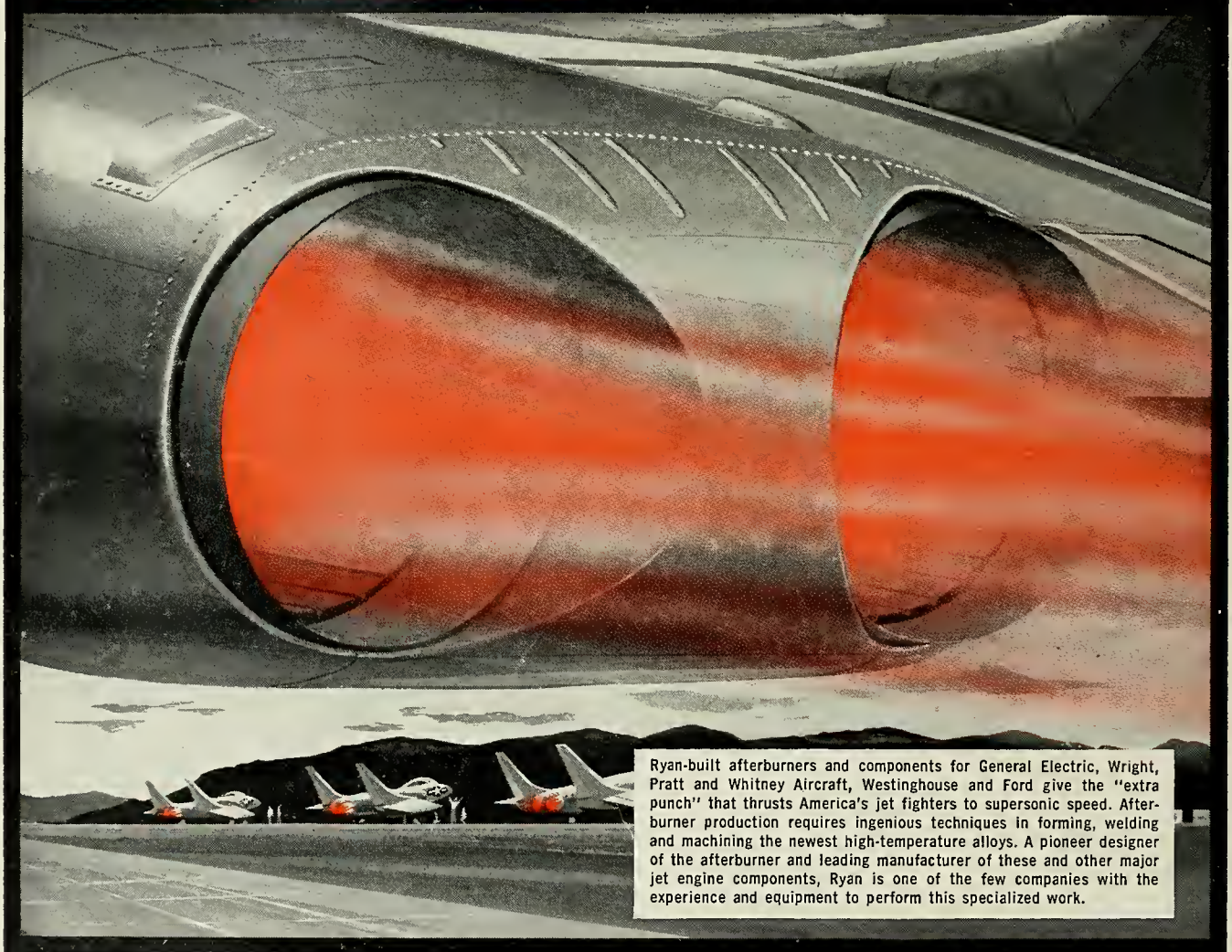
RYAN AFTERBURNERS BLAST U.S. JETS AHEAD



Ryan-built afterburners and components for General Electric, Wright, Pratt and Whitney Aircraft, Westinghouse and Ford give the "extra punch" that thrusts America's jet fighters to supersonic speed. Afterburner production requires ingenious techniques in forming, welding and machining the newest high-temperature alloys. A pioneer designer of the afterburner and leading manufacturer of these and other major jet engine components, Ryan is one of the few companies with the experience and equipment to perform this specialized work.

Another Example of How

RYAN BUILDS BETTER

Because Ryan has tackled and licked the difficult, challenging jobs of the jet age, leading engine makers not only depend on Ryan for production of current models but also for new product development and initial manufacture of complex components for power plants of entirely new design. The only jet parts maker that also designs, builds and flies jet aircraft, Ryan has proven its ability to build to jewel-like precision the "hot parts" and major components for jet, piston, rocket and ramjet engines.

And in other fields, too — aircraft design, airborne electronics, drone missiles, basic research and development — Ryan has demonstrated the know-how which comes only from a background of 32 years in building planes and aeronautical products. Ryan's deserved reputation is built on producing only the best, delivering on time, and at minimum cost.